Work Plan

for the . . .

Remedial Investigation and Feasibility Study

of the . . .

Albion-Sheridan Township Landfill
Albion, Michigan
May, 1992

prepared for . . .

U.S. Environmental Protection Agency
Region V
Chicago, Illinois

EPA Contract No. 68-W8-0079
EPA Work Assignment No. 11-5LAN
WW Engineering & Science Project No. 04011

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN
ALBION-SHERIDAN TOWNSHIP LANDFILL
ALBION, MICHIGAN

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
CHICAGO, ILLINOIS

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MAY 1992

PROJECT 04011

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AAD	Alternatives Array Document
ARARs	Applicable or Relevant and Appropriate Requirements
ARCS	Alternative Remedial Contract Strategy
C/B	Cost Benefit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CLP	Contract Laboratory Program
CRL	Central Regional Laboratory
ECAO	Environmental Criteria and Assessment Office (U.S. EPA)
EDD	Enforcement Decision Document
EM	Electromagnetic
FIT	Field Investigation Team
FS	Feasibility Study
GC	Gas Chromatograph
HEAST	Health Effects Assessment Summary Tables
HRS	Hazard Ranking System
ISCST	Industrial Source Complex Short-Term
IRIS	Integrated Risk Information Systems
MDL	Method Detection Limit
MDNR	Michigan Department of Natural Resources
NCP	National Contingency Plan
NPL	National Priorities List
NWS	National Weather Service
O&M	Operation and Maintenance
ORV	Off-road Vehicle
POTW	Publicly-owned Treatment Works
PRG	Preliminary Remediation Goals
PRP	Potentially Responsible Parties
PVC	Polyvinyl chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Risk Assessment
RCRA	Resource Conservation and Recovery Act
RFD	Reference Doses
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SF	Slope Factors
SITE	Superfund Innovative Technology Evaluation
TAT	Technical Assistance Team
TSD	Treatment, Storage, and Disposal
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service
VOC	Volatile Organic Compound
WWES	WW Engineering & Science, Inc.

1.0 INTRODUCTION

1.1 BACKGROUND

On October 4, 1989, the Albion-Sheridan Township Landfill was added to the United States Environmental Protection Agency (U.S. EPA) National Priorities List (NPL) by the U.S. EPA (54 Federal Register 41000, 41021) . A Remedial Investigation/Feasibility Study (RI/FS) of the Albion-Sheridan Township Landfill site was authorized under EPA Work Assignment No. 11-5LAN, executed January 13, 1992 between the U.S. EPA and WW Engineering & Science, Inc. (WWES).

This Work Plan describes the scope of work and methods proposed for the RI/FS of the Albion-Sheridan Township Landfill site in Albion, Michigan. The proposed work will be performed for the U.S. EPA under EPA Contract No. 68-W8-0079 by WWES. The Remedial Investigation/Feasibility Study will be conducted under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA).

The objectives of the Remedial Investigation (RI) will be to assess and evaluate the potential extent and magnitude of on-site and off-site contamination at the Albion-Sheridan Township Landfill site. Based on the results of the RI and Risk Assessment (RA), a Feasibility Study (FS) will be completed to recommend a cost-effective, technically viable remedial alternative for mitigating the hazard posed by the contamination.

The investigations outlined in this work plan incorporate procedures and methodologies provided in recent U.S. EPA guidance designed specifically to address municipal landfill sites (Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites, February 1991). The guidance is designed to expedite the characterization of a municipal landfill site by focusing field activities on the information needed to 1) sufficiently assess risks posed by the site, and 2) evaluate practicable remedial actions. The similarity in landfill characteristics and the National Contingency Plan (NCP) expectations, make it possible to streamline the RI/FS for municipal landfills with respect to characterization, risk assessment and the development of remedial action alternatives. A major component in the implementation of this guidance is the expectation that most municipal landfill sites present a relatively low, long-term threat to human health and the environment and that containment technologies are generally the most appropriate remedial alternatives.

The Albion-Sheridan Township Landfill site has been selected by the U.S. EPA as a pilot site for implementing methodologies presented in the Municipal Landfill RI/FS Guidance. At the direction of U.S. EPA, a phased approach to site investigations has been prepared to streamline both the time frame and the cost of the overall RI/FS activities, where possible. As outlined in this work plan, decisions on the extent of several aspects of the investigations will be made throughout the RI/FS process with the concurrence of U.S. EPA after consultation with the Michigan Department of Natural Resources (MDNR).

1.1.1 SITE LOCATION AND DEFINITION

The Albion-Sheridan Township Landfill site (the "site") is a former landfill located approximately 1 mile east of Albion, Michigan in Section 36 (T2S,R4W) of Calhoun County (see Figure 1). The site is defined as Lot 27 and Lot 28 of the Supervisor's Plat.

The site is comprised of approximately 30 acres of land which was formerly owned by Mr. Gordon Stevick. It is bordered on the north by Michigan Avenue (also known as State Route 99), on the east by the Calhoun/Jackson County line, and on the south by East Erie Road. The western boundary of the site is approximately 660 feet west of the Calhoun/Jackson County line. Two small parcels of Lot 27, 1 in the northeast corner and 1 in the northwest corner, have never been owned by Mr. Stevick, and therefore, are not included in the site (see Figure 2). Currently, those portions of Lot 27 and Lot 28 formerly owned by Mr. Stevick are parceled into the 4 segments shown in Figure 3. Only 1 parcel, Parcel C in Lot 28, was retained by Mr. Stevick.

The area under investigation (the "study area") primarily consists of all portions of Lot 27 and Lot 28 which were owned by Mr. Stevick during active landfilling operations. It is anticipated that adjacent areas will also be included in the study area to some extent, in order to establish sampling locations for collecting surface water, ground water, and soil samples to characterize background levels and to help determine the risk to human health and the environment.

1.1.2 Waste Disposal/Ownership History

From 1966 to 1981, the landfill was privately owned and operated by Mr. Gordon Stevick. The landfill reportedly accepted municipal refuse and industrial wastes from the City of Albion and nearby Sheridan Township. In the early 1970s, the MDNR approved the landfill to accept metal plating sludges described as insoluble hydroxides and carbonates. The exact volume of metallic sludges received by the landfill is unknown, but the Site Inspection Report (Ecology and Environment, 1986) estimated as much as 6,000 cubic yards of sludge were accepted. Other materials, such as paint wastes and thinners, oil and grease, and dust, sand, and dirt containing fly ash and casting sand are also believed to have been disposed of at the site. Near the time the landfill closed, Scott's Disposal Service, Inc. purchased some land in the northern part of the site to use as a waste transfer station.

1.1.3 Environmental Settings

1.1.3.1 Surface Features

The Albion-Sheridan Township Landfill is located in a predominantly rural-residential and commercial area on the east side of Calhoun County. The landfill surface elevation is approximately 970 feet; the site has approximately 15-feet of relief. The site topography has been altered by extensive excavation and fill activities. The site currently consists of gently sloping land (1 to 3%) from north to south.

Since cessation of landfilling activities, the northeastern side of the landfill has undergone significant revegetation, while the southern and western sides of the site are less densely covered. The eastern and western boundaries of the site consist of thinly wooded areas.

Several large piles of demolition debris and a large excavation are located on the northern portion of the site. Other significant features of the site include an occupied home and trailer near the southern boundary of the site, an abandoned storage/guard shed on the southeastern portion of the site, and 2 partially buried fuel-storage tanks, connected to inoperable gasoline pumps (each tank is estimated to be 500-gallons, Weston, January 1990).

There are no surface water bodies currently located on the landfill itself. The 7.5 minute series, Northeast Albion, Michigan, United States Geological Survey (USGS) quadrangle map (1981) shows a small pond on the southern portion of the site. An aerial photograph taken on April 18, 1981 indicates that liquids no longer existed in this area. This "pond" is suspected to be the site of a former sand and gravel borrow pit. No surface water bodies were indicated to be on the site in an aerial photograph taken on October 2, 1990 and none were observed while inspecting the site in preparation of these project plans.

Surface water near the landfill includes wetland areas south and east of the site and the North Branch of the Kalamazoo River, located approximately 400 feet south of the site. In addition, a former wetland area is located off site just northwest of the landfill. Surface water runoff from the site to the river and wetlands to the south is impeded by the railroad grade south of Erie road. Wetlands making up the headwaters of the South Branch of Rice Creek are located approximately 1.5 miles northeast of the site.

An aerial photograph dated 1961, indicates that the historical use of lands neighboring the landfill to the west, north and east was agriculture. Since 1961 the adjacent area has transformed from agricultural use to mostly rural-residential and commercial uses. Aside from gardens at a few neighboring homes, a 1990 aerial photograph of the area immediately surrounding the landfill did not show recent agricultural activity. An active swine operation, however, is noted in a photograph of adjacent property to the northeast taken in 1989. Maps and historical aerial photographs do not indicate a developed use of land south of Erie Road adjacent to the North Branch of the Kalamazoo River (Environmental Monitoring Systems Laboratory, January 1991).

1.1.3.2 Soils/Geology/Water Supply

Soils in the vicinity of the site are comprised of glacial deposits from Wisconsian-aged outwash plains. These outwash deposits are reported to be predominantly sands and gravels. Discontinuous clay, or silty clay, layers may be interbedded within the coarser materials and may also directly overlie the bedrock surface. The approximate thickness of the glacial deposits ranges between 26 and 36 feet at the site based upon 3 on-site monitoring well records (MDNR, 1992, open file).

The bedrock beneath the site is comprised of Mississippian-aged sandstones of the Marshall Formation. These sandstones serve as the primary aquifer for private, public, and industrial water supply in the area. In 1980, the water table was encountered approximately 12 to 26 feet below ground level, within the glacial overburden (MDNR, 1992, open file). These 2 aquifers are believed to be hydraulically connected with ground water flowing in a south to southwesterly direction towards the North Branch of the Kalamazoo River.

Based on 1980 census figures, it was estimated that 13,500 people receive water from public or private wells within a 3-mile radius of the site. A private well was located in the southern portion of the site to provide water to a residence once occupied by the landfill operator. This 108 foot deep well was completed in bedrock. A sample collected from this well in October 1989 was analyzed for volatile organic compounds (VOCs), none were detected.

Two wells used for water supply for the Amberton Village Subdivision, are located approximately 1000 feet east of the site. Both of these bedrock wells were drilled to a depth of 350 feet and are cased to a depth of 95 feet.

Three of Albion's municipal wells are located approximately 1 mile west of the site. These wells are completed in the Marshall Sandstone at depths ranging from 254 to 260 feet. Casing extends 76 feet below ground in 2 of the wells, and 58 feet below ground level in the third.

1.1.3.3 Known or Potential On-Site/Off-Site Effects

A variety of materials are suspected to have been disposed in the landfill (including metal plating sludges, paint sludges, and solvents). Such disposal could result in several potentially significant environmental impacts due to contaminant migration. Environmental sampling to identify potential impacts, however, has been limited to date. In 1980, metal plating sludges disposed at the site were analyzed by the Michigan Department of Natural Resources (MDNR, August, 1980) and were found to contain the following contaminants: chromium at 250,000 mg/kg, zinc at 150,000 mg/kg, nickel at 1,000 mg/kg, lead at 280 mg/kg, and cyanide at 2,100 mg/kg. No other chemical analyses of soils or other buried material are known to exist.

Monitoring well data at the landfill is limited. On 3 occasions (in 1980 and 1981) ground water samples were collected by the MDNR from 3 monitoring wells installed on the site in 1980. The samples were analyzed for several water quality parameters and metals (MDNR, 1986). Table 1 provides a summary of the ranges of analytical results for each parameter from the 3 wells on the 3 sampling occasions. Recent sampling and analysis of the Amberton Village Subdivision wells has not detected impact by either VOCs or metals (Weston, January 1990). One nearby resident, however, indicated that pipes and pumps associated with a potable well northwest of the site corroded due to what may be contaminants present in the ground water.

Environmental sampling to identify potential impacts of site activities on air, ground water, soils, surface waters, and sediments at neighboring properties has not been conducted.

Two other sites of known or suspected environmental contamination are located near the site. These are the Brooks Foundry site located approximately 0.25 miles west of the landfill, and the McGraw-Edison facility located 0.5 miles northwest of the landfill. Both of these sites are listed on Michigan's Act 307 list of Sites of Environmental Contamination. The McGraw-Edison facility is also on the U.S. EPA NPL and cleanup of trichloroethene contaminated ground water is currently underway. Production well(s) at the Brooks Foundry and extraction wells at the McGraw-Edison facility may be influencing ground water flow in the study area. Available data regarding wells at these 2 sites will be reviewed to assist in fully defining and understanding ground water flow patterns in the study area indicated during the evaluation of data collected during the proposed RI.

1.1.3.4 Potential Receptors

Human

The closest residences include a home and trailer located directly adjacent to former landfilling areas on the south side of the site. Adjacent residences are also located north of the landfilling area along Michigan Ave. A sub-division containing numerous homes is located approximately 200 feet east of the landfill. Several homes are also located along Erie Road, less than 800 feet southwest of the landfill. More densely populated areas within the City of Albion are located approximately 1 mile west of the site.

As discussed above, it is estimated that 13,500 people obtain drinking water from public or private wells within a 3-mile radius of the landfill. Of these, approximately 2,300 people are reported to be private well users. The municipal water supply wells located within 3 miles of the site include; 1) two wells operated by the Amberton Village Subdivision which are located 1,000 feet east of the site, 2) three of the City of Albion's municipal wells which are located approximately 1 mile west of the site, and 3) four of the City of Albion's municipal wells are located approximately 2.5 miles west of the site.

Some nearby residential wells have been sampled as recently as 1989, to determine the presence of potentially impacted drinking water. These investigations were conducted mainly due to suspected contamination at the 2 nearby sites (the Brooks Foundry site and the McGraw-Edison facility). VOCs were reportedly detected in 3 of 22 wells sampled during these investigations (Michigan Department of Public Health, November 6, 1989).

As stated previously, limited sampling of monitoring wells on the landfill indicate the presence of elevated concentrations of several inorganic and general water quality parameters which may pose a threat to nearby residential users. Because neighboring residences obtain their water from ground water wells, ground water ingestion, dermal adsorption of contaminants in water, and inhalation of contaminants volatilized from water are potentially significant routes of contaminant exposure near the landfill.

Potential health hazards may also result from direct contact with cyanide in sludges by children and other trespassers accessing the site. While warning signs have been posted, and fencing and gates have been installed in several areas, footprints, off-road vehicle (ORV), and snowmobile tracks have been frequently observed on-site. Access to the site can be gained through wooded areas along the western and eastern boundaries. Land directly west of the landfill show signs of significant recreational vehicle traffic.

Other potential human exposure pathways of significance include: ingestion of contaminated fish and game, incidental ingestion of surface water and sediments, dermal contact with contaminated soils, surface waters, and sediments, and inhalation of volatilized contaminants and contaminated fugitive dusts.

Ecological

Contaminants at the site and contaminants migrating from the site could potentially impact terrestrial plant and animal life on and surrounding the landfill. These populations are likely to be typical of woodland and open land populations of Lower Michigan. Contaminant migration could also impact nearby aquatic populations. This potential is increased due to the landfill's proximity to the North Branch of the Kalamazoo River as well as several apparent wetland areas. Regional ground water flow is believed to be to the south-southwest, in the direction of the neighboring river. The ground water flow direction will be more precisely defined during the hydrogeologic investigations of this RI.

1.1.4 RESPONSE ACTION ACTIVITIES

MDNR officials inspected Scott's Disposal Service, Inc., a transfer station facility, and found numerous health violations in 1983. The transfer station eventually closed, and Scott's Disposal Service, Inc. went out of business. In 1984, MDNR funded an action in which they removed approximately 1,000 cubic yards of general household refuse which had been left by Scott's Disposal Service, Inc. at the transfer station site.

In 1986, a U.S. EPA Field Investigation Team (FIT) contractor, was tasked to perform a Site Screening Inspection for purposes of scoring the site per the Hazard Ranking System (HRS). The results of this inspection are documented in a report entitled "U.S. EPA Site Screening Inspection Report, Albion-Sheridan Township Landfill, Albion, Michigan", Ecology and Environment, March 19, 1986.

During the summer of 1990, a removal action took place at the site to remove drums on the surface of the landfill. Several of the drums sampled contained listed hazardous waste. The action was performed by 2 Potentially Responsible Parties (PRPs) under a Unilateral Administrative Order from U.S. EPA. The removal action was supervised by the Weston Technical Assistance Team (TAT), a U.S. EPA contractor (Weston, September 30, 1990). It is not certain whether additional drums are buried at the site. A former waste hauler indicated that drums of paint sludges were dumped at the site and may still be buried within the landfill.

1.1.5 DATA GAPS

The following site characteristics need further investigation before performing an assessment of the environmental and health affects of contaminants and identifying potential remedial alternatives:

- The extent of landfilled and covered landfill areas;
- The content, construction and integrity of the landfill cover materials;
- Ground water elevation and direction of ground water flow at the landfill;
- The hydrogeologic relationship between ground water and nearby surface water features (including the river and wetlands neighboring the site);

- The hydrogeologic relationship between potentially contaminated ground water beneath the landfill and aquifers used for private residential and municipal water supplies;
- Background soil and ground water quality;
- The nature and extent of any ground water contamination;
- The estimated extent and direction of historic off-site contaminant migration by surface water runoff and wind erosion;
- The location and extent of any areas of highly toxic and/or mobile material that pose potential principal threats to human health and the environment (hot spots) which are identified during RI activities; and
- Concentrations of chemicals in media that people may be exposed to.

1.1.6 CONCEPTUAL MODEL

The "conceptual model" is an understanding of the site that identifies all potential or suspected sources of contamination, types and concentrations of contaminants detected at the site, potentially contaminated media, and potential exposure pathways, including receptors (U.S. EPA, 1989a). Figure 4 illustrates the conceptual model of the site.

Important elements of the conceptual model for the site include:

- Municipal and industrial wastes were disposed in the Albion-Sheridan Landfill.
- Hazardous materials potentially disposed on-site include inorganic compounds (metals), organic solvents, and other semi-volatile organic compounds.
- There is a potential for contaminants in soil and buried wastes to leach to ground water.
- Contaminated ground water from the site may flow into surrounding surface waters and wetlands.
- Contaminated ground water from the site may impact nearby water supply wells.
- There is a potential for chemicals to volatilize from soil into the air.
- There is the potential for generation of chemical-affected fugitive dust from the site.

- There is potential for transport of contaminated soil from the site by erosion.
- There is the potential for contamination of fish populations found in impacted surface water bodies.
- There is the potential for contamination of wildlife populations inhabiting landfill property and wetland areas.
- Potential human receptors include residents living near the site and persons using the site and surrounding areas for recreation.
- The potential routes of exposure to site-related contaminants are: ingestion and dermal absorption of contaminants in soils, the ingestion, dermal absorption and inhalation of contaminants in ground water, the inhalation of volatilized chemicals and chemical-affected particulates from soils, ingestion of contaminated fish, game, or plants, and the ingestion and dermal absorption of contaminants in surface water and sediments.

The conceptual model is used to identify "areas of concern". Areas of concern refer to the general sampling locations at or near the site. The RA will evaluate each area of concern and the site as a whole. One purpose of a RA is to identify and characterize the hazards in a way that will contribute directly to the selection of a final remedy (U.S. EPA, 1989a).

Because options for remedial action at municipal landfill sites are limited, it may be possible to streamline or limit the scope of the RA by:

1. Using the conceptual site model and RI-generated data to justify limited or qualitative risk assessments of some affected media and pathways. For instance, if evaluation of ground water conditions indicates that a landfill cap is necessary to address exposures to contaminants in ground water, it may not be necessary to fully characterize exposures to surface soils as the potential threats from this media would be eliminated by the cap. A landfill cap would also reduce potential exposures related to surface water runoff, landfill gas emissions, and leachate generation.

2. Comparing site data to pathway specific applicable or relevant and appropriate requirements (ARARs) or other risk-based chemical concentrations to initially identify the potential magnitude of threats to human health and the environment. Clear exceedance of these standards for one or more chemicals would in itself be

sufficient basis to warrant remedial actions prior to completion of a quantitative RA including all contaminants and multiple exposure pathways.

The steps outlined above may allow for early implementation of remedial actions. Ultimately, however, it will be necessary to demonstrate that the final remedy, once implemented, will in fact address all pathways and contaminants of concern. Furthermore, any early actions developed under this approach will be flexible so that potential revisions deemed necessary by the final RA can be incorporated.

2.0 REMEDIAL INVESTIGATION

2.1 PURPOSE

The purpose of the remedial investigation is to evaluate the potential extent and magnitude of on-site and off-site contamination related to waste disposal at the Albion-Sheridan Township Landfill and to use this information to evaluate the potential risk to the environment and public health and welfare. A sufficient amount of data of adequate technical content will be collected to support quantitative and qualitative human and ecological risk assessments at the site as well as support the evaluation of remedial alternatives during the feasibility study. All data gathered will be obtained in accordance with the Quality Assurance Project Plan (QAPP) and the Sampling and Analysis Plan (SAP).

The remedial investigation and risk assessment tasks presented in this work plan have been designed to incorporate streamlining methodologies outlined in the Municipal Landfill RI/FS Guidance. The main goal of this guidance is to focus field activities and other investigations on information needed to adequately assess risks posed by the site and to evaluate practicable remedial actions. A major tenet of the guidance is that containment remedies are generally most appropriate at municipal landfill sites, and that site investigations should be designed, where appropriate, to support the presumptive remedy.

This work plan incorporates, where possible, a phased approach to site investigations. The phased approach will allow for expedited landfill characterization. Decisions on the extent of several aspects of the investigations will be made following review of information gathered in earlier phases and with the concurrence of U.S. EPA after consultation with the MDNR. As an aid in the streamlining approach, risk assessment tasks outlined in this work plan are designed to identify early on the most significant potential health threats. Exposure pathways of greatest significance will be quantitatively addressed in the RA for the site, while those determined to be of secondary importance will be addressed qualitatively, if possible.

The specific objectives of the RI are to:

- Characterize contamination present at the site;

- Characterize the source(s) of potential contamination;

- Characterize the hydrogeologic and physical setting, and evaluate the most likely contaminant migration pathways and physical features that could affect potential remedial actions;

- Determine the migration rates, extent, and characteristics of any contamination that may be present at the site;

- Gather sufficient data to assess the risk to public health and the environment; and

- Support the development and evaluation of viable remedial alternatives in the FS.

2.2 SCOPE

The RI will be conducted in a phased approach. This was chosen to assure that planning for each data collection event was based on an understanding of where the data should be collected and why. This Work Plan anticipates a phased investigation by including contingency sampling locations for the media being investigated.

The scope of the RI consists of 7 tasks:

- Project Planning

- Field Investigations, including:

  - Geophysical Investigations;

  - Landfill Characterization and Landfill Cover Evaluations;

  - Hydrogeological Investigations;

  - Surface Water Investigations;

  - Sediment Investigations;

  - Residential Well Sampling;

  - Surface Soil Investigations;

  - Ecological Investigations;

  - Air Modeling, if necessary;

- Test Pitting, if necessary; and
- Soil Vapor Investigations, if necessary.

- Sample Analysis/Validation
- Data Evaluation
- Baseline Risk Assessment
- Bench/Pilot Testing Studies
- Reports

2.3 PROJECT PLANNING

Five project plans have been prepared to guide the RI/FS work for the Albion-Sheridan Township Landfill site. The 4 plans, in addition to this Work Plan include: the QAPP, SAP, Data Management Plan, and a Health and Safety Plan.

2.3.1 WORK PLAN

This Work Plan has been developed and is designed to characterize the site and its actual or potential hazard to the public health and the environment. It is based on background information contained in the U.S. EPA files, conversations with the U.S. EPA and MDNR, and a site visit. The Work Plan specifies additional field investigations which need to be performed, general methods to perform the work, personnel requirements, and a schedule for the proposed work.

2.3.2 SAMPLING AND ANALYSIS PLAN

All work conducted during the investigation will be governed by the Work Plan. The SAP and the QAPP are intended to supplement the Work Plan. The SAP includes a statement of sampling objectives, procedures, sampling locations, and analytical methods.

2.3.3 QUALITY ASSURANCE PROJECT PLAN

The QAPP outlines the quality assurance objectives of the investigation and the specific procedures which will be utilized to ensure that the data gathered at the site will meet the goals of accuracy, precision, completeness, and representativeness. The QAPP also specifies sampling handling and shipping requirements.

2.3.4 HEALTH AND SAFETY PLAN

All field work conducted on the Albion-Sheridan Township Landfill site will be performed in accordance with the guidelines specified in the Health and Safety Plan. The Health and Safety Plan has been developed to minimize any potential hazards to the Alternative Remedial Contract Strategy (ARCS) investigation team or the surrounding community from activities undertaken during the field investigation. The plan addresses all applicable health and safety requirements and defines personnel responsibilities, protective clothing and equipment needs, operating protocols and procedures, decontamination requirements, training, medical emergency information and other pertinent guidance.

2.3.5 DATA MANAGEMENT PLAN

A common data base will be developed that will compile all laboratory analytical data that are generated for the Albion-Sheridan Township Landfill. The data base will have an Oracle format. Data may then be retrieved from a Lotus or Excel spreadsheet in the desired format to produce a variety of report formats. Besides ease of manipulation, the data base will provide better data integrity and security, eliminating the possibility of errors due to transferring data from one form of media to another. A more detailed description concerning data management is included in the Data Management Plan.

2.4 PROJECT MANAGEMENT

WWES personnel, along with necessary qualified subcontractors, will perform the field investigations. All project management will be provided by WWES as described in Section 4.0.

Project accomplishments and status will be documented in a monthly progress report. Reports will be submitted by the 20th day after the end of the reporting month. Each report will address the following items as identified in our scope of work:

- Identification of site and activity;
- Status of work at the site and program;

- Percentage of completion and schedule status;
- Difficulties encountered during the reporting period;
- Actions being taken to rectify problems;
- Activities planned for the next month;
- Changes in personnel;
- Actual expenditures (including fee) and direct labor hours expended for this period;
- Cumulative expenditures (including fee) and cumulative direct labor hours;
- Projections of expenditures for completing the project, including an explanation of any significant variation from the forecasted target; and
- A graphic representation of proposed versus actual expenditures (plus fee) and comparison of actual versus target direct labor hours (a projection to completion will be made for both).

The monthly progress report will list target and actual completion dates for each element of activity, including project completion, and will provide an explanation of any deviation from the milestones in the Work Plan.

2.5 REMEDIAL INVESTIGATION FIELD ACTIVITIES

2.5.1 SUPPORT FACILITIES, MOBILIZATION, AND SUBCONTRACTS

Prior to initiating the remedial field investigation, it will be necessary to establish field support facilities, procure subcontractor services, and identify, obtain, and mobilize equipment and materials. During this process, proper and thorough documentation of all procurement, field support and equipment mobilization activities will be maintained. Specific work items associated with each of these categories are listed below:

<u>Procure Subcontractor Services</u>

- Select construction subcontractor to grade area as required to locate field support facilities. If necessary, clean fill will be trucked in and spread at the support facility location.

- Select construction subcontractor to construct an equipment washdown and decontamination pad and lined contaminated wash water storage tank.

- Select surveying subcontractor(s) to verify and stake the site boundary, prepare a topographic site map, establish a survey grid across the site, and set temporary benchmarks and landfill subsidence monuments.

- Select construction subcontractor to complete the perimeter fence.

- Select drilling subcontractor(s) to conduct the installation of soil borings and monitoring wells.

- Rent and set up project office trailer.

- Construct an equipment washdown and decontamination pad and lined contaminated wash water storage tank.

- Set up sampling equipment decontamination area.

- Set up personnel decontamination area.

- Arrange for telephone and electrical hook-up at the site project trailer.

- Arrange for on-site water and sewage facilities.

- Arrange for pickup of uncontaminated wastes generated during field activities.

- Arrange for disposal of purge and decontamination water.

- Select subcontractor to install soil vapor probes, if necessary.

- Select subcontractor to excavate test pits, if necessary.

Mobilize Equipment and Materials

- Schedule and obtain expendable and non-expendable health and safety equipment.

- Schedule and obtain all necessary sampling equipment.

- Schedule and obtain all necessary sampling bottles, preservatives, coolers, etc.

- Obtain all miscellaneous items needed on-site (paper, pens, telephone books, etc.)

2.5.1.1 Solicitation

Whenever possible, subcontracts will be offered first to the pre-qualified pool of subcontractors that WWES has assembled through regular open announcements and invitation. Exceptions to this may be subcontracts that are set aside for small business enterprises, small disadvantaged businesses, woman-owned businesses, or subcontracts that call for services that are not represented in the existing subcontractor pool.

Bid proposal documents will be offered to a sufficiently large number of potential bidders to assure price competition. Sealed bids will be accepted until a set deadline and will be opened on a pre-established date and time. Depending upon the complexity of the subcontract and/or site conditions, a pre-bid meeting may be scheduled to answer bidders' questions and examine the site. If deemed appropriate by WWES, attendance at the pre-bid meeting may be mandatory for potential subcontractors wishing to submit a bid. Such conditions and information will be clearly stated in the bid proposal documents.

2.5.1.2 Award

Only bid proposals received by the established deadline will be opened and considered.

Bids will be reviewed for accuracy and compliance with stated bid requirements. WWES will notify the U.S. EPA Contracting Officer of bid results for subcontracts less than $25,000 and will request written approval for subcontract award from the Contracting Officer for subcontracts of $25,000 or more. After receiving concurrence or, if necessary, written approval from the Contracting Officer, the subcontract will be awarded to the successful bidder. WWES will obtain the proper insurance certificates and, if necessary, performance and payment bonds, and will submit the subcontract documents to the successful bidder for execution.

2.5.1.3 Administration

WWES will issue a Notice to Proceed to the subcontractor which will begin the stipulated subcontract completion period. Subcontractor progress will be inspected and measured by WWES staff and progress payments will be processed not more often than monthly. Subcontracts based upon detailed unit price bids will be measured on a daily basis and a summary of quantities completed and amounts earned will accompany the

2.3.2 Landfill Cover Evaluation

Measurements of the thickness of the landfill cover will be taken in split-spoon samples collected at each landfill characterization sampling location and at 5 additional locations (total of 8) throughout the landfill. The ultimate locations for collection of landfill cover samples will be selected after the surface geophysical survey has defined the lateral extent of the landfill. Measurements of particle sizes of each landfill cover sample will be performed in accordance with appropriate American Society for Testing and Materials (ASTM) standards. A summary of the number of landfill cover samples to be measured and the specific physical properties to be measured is presented in Table 3. The particle size measurements will be performed by WWES.

2.4 HYDROGEOLOGICAL INVESTIGATION

2.4.1 Subsurface Soil Investigation

2.4.1.1 Sampling Locations and Analyses

Soil samples will be collected at each of the monitoring well locations described in Section 2.4.2 to define the physical characteristics and nature and extent of soil contamination, if any, in the subsurface. Based on the monitoring well locations proposed, it is anticipated that subsurface soil samples will be collected at a minimum of 13 locations and a maximum of 15 locations (see Figure 2).

The 2 northernmost locations are anticipated to lie in areas which have not been affected by landfill activities and are, therefore, anticipated to provide background data essential to evaluating comparatively the results of chemical analyses of soils specific to the site.

2.4.1.2 Sampling Equipment and Procedures

Documentation of subsurface soil lithologies will be kept in accordance with WWES' "Well Boring/Logging Guidelines" and "Soils Classification" SOP's.

Soil boring samples will be collected through hollow stem augers with a 2-foot long split spoon sampler that has a 3-inch inside diameter using methods described in WWES' "Split-Spoon Sampling" SOP. The 4 locations in the wetlands adjacent to the North Branch of the Kalamazoo River will be sampled using a hand auger.

Split-spoon samples will be collected continuously from the existing ground surface to the top of bedrock at 6 of the locations, (MW-1 through MW-6). At each of the remaining locations, except those within the wetlands, split-spoon samples will be collected at 2.5-foot intervals in the first 10 feet and thereafter at 5-foot intervals to the bottom of the deepest borehole. Continuous sampling will be accomplished with a hand auger at the 4 locations within the wetlands south of the site.

All equipment used for collection of the subsurface soil samples will be decontaminated by washing or steam cleaning in accordance with WWES' "Decontamination, Downhole Sampling Equipment" SOP. Hexane, acetone, and/or methanol will only be used if visible oil or dirt cannot be removed from the sampling equipment by conventional steam cleaning or washing techniques. This will reduce the possibility of introducing volatile contaminants into a sample. The use of hexane, acetone or methanol will be documented on the boring log.

Any boring requiring abandonment will be grouted from the bottom of the borehole to the ground surface with a cement/bentonite grout in accordance with WWES' "Soil Boring Grouting" SOP.

2.4.1.3 Sample Analyses

At 5-foot intervals during sampling of soils above the water table, qualitative measurements of methane gas emanating from the augers will be taken. The measurements of methane gas will be taken with a methane-specific Draeger tube. Procedures for sampling and measuring for methane will be conducted in accordance with the manufacturers instructions. A headspace analysis will be performed on a portion of each split-spoon sample collected above the water table with a PID or FID in accordance with WWES' SOP, "Jar Headspace Measurements in Unsaturated Soil Samples."

Since monitoring well locations will be selected in areas beyond the extent of impact from landfill activities, based on the surface geophysical survey, no specific subsurface soil samples are anticipated to be submitted for chemical analyses at this time. Upon completion of sampling of subsurface soils during the installation of the 6 initial bedrock monitoring wells described in Section 2.4.2, a determination of the need or benefit of submitting samples for chemical analyses will be made. If deemed necessary, samples from intervals of concern will be collected for submittal to a laboratory from borings drilled during the installation of monitoring wells in the glacial aquifer. Soil from sampling intervals that register 2 times above the ambient air during screening with the PID, are visibly stained, or have an unusual odor or color will especially be considered for submittal for chemical analyses. Soil samples to be considered for submittal for chemical analyses from remaining locations will be selected in a similar manner. The ultimate decision on whether or not to submit samples for chemical analyses and which samples will be submitted will be made by the U.S. EPA RPM in consultation with the MDNR.

If subsurface soil samples are submitted for chemical analyses, 4 representative soil samples from each soil type encountered at the background locations (MW1 and MW2) will be submitted for the chemical analyses also. It is anticipated 2 soil types will be encountered, therefore; a total of 8 background soil samples would be submitted.

Based on the assumption that the water table will be encountered within 25 feet of the ground surface, it is anticipated that the scope of the subsurface soil sampling may include the submittal of up to 45 investigative samples and 5 duplicates for chemical analysis. Trip blanks (deionized water blanks) will also be prepared and submitted for laboratory analysis in accordance with WWES' "Field QC Sample Guidelines" SOP. Trip blanks will accompany each cooler containing VOC samples. Table 4 summarizes the maximum estimated number of samples submitted and DQO for each chemical analyses.

Any samples submitted for VOC analysis will not be composited in order to prevent the loss of volatiles. All other samples submitted for chemical analyses will be composited in a stainless steel bowl using a stainless steel spatula. The cation exchange capacity (CEC) of samples from soils below the water table at 6 locations (MW-1 through MW-6) will also be measured in accordance with the Region V SAS.

If a clay-rich layer that is greater than 2-feet thick is encountered while drilling, a Shelby tube sample will be collected in accordance with WWES' SOP "Shelby Tube Sampling." Measurements of Atterberg Limits, permeability, and particle size will be taken in accordance with appropriate ASTM methods (D4318, D2434, and D422, respectively) on each Shelby tube sample. It is anticipated that no more than 2 clay layers will be encountered in the 5 borings drilled to the top of bedrock and 1 clay layer will be encountered at each of the remaining 16 locations. These measurements of physical parameters will be conducted by WWES. Table 4 summarizes the estimated number and DQO for each physical parameter measurement.

2.4.2 INSTALLATION OF MONITORING WELLS

A maximum of 37 ground water monitoring wells will be installed at up to 15 tentative locations (see Figure 3) during Phase I of this RI. At some of the locations it is possible that no wells will be installed. A summary of all proposed and optional wells at each location is provided in Table 5. The ultimate determination of the number of wells required to define ground water flow and quality characteristics will be based on results of the geophysical survey and after 6 of the initial monitoring wells have been installed and preliminary ground water data are available. A flow chart for criteria used to determine the number of bedrock monitoring wells ultimately installed during Phase I is provided in Figure 4. The number of monitoring wells installed in the glacial deposits will be dependent on the number of locations at which bedrock wells are installed and the thickness of the glacial aquifer.

Based on results of field screening and the downhole geophysical survey, optimal well screen placement will be determined. It is anticipated that 1 well at each location will be screened immediately below the top of the water table. Other wells may be installed immediately above the bedrock and/or in the bedrock.

Initially, the bedrock wells at 5 locations (MW-1 through MW-5) will be installed. Upon completion, the top of casing elevation of each monitoring well will be surveyed in accordance with WWES' "Elevation Surveys for Monitor Wells" SOP. Water levels will be collected in accordance with WWES' "Water Level Measurements" SOP. Based on the calculated ground water flow direction resulting from measurements made in these 5 wells, the deep bedrock well at MW-6 will be installed directly downgradient from the site.

Two well clusters will be installed upgradient of the landfill (MW-1 and MW-2). These clusters will be located on privately owned property and U.S. EPA assistance will be sought in obtaining permission to install these, and other off-site wells, at suitable locations.

The deepest well will be drilled at each cluster location first. Soil sampling of unconsolidated materials will be accomplished with a split-spoon sampler and Shelby tubes as described in Section 2.4.1 above. Sampling of bedrock will be performed as described in Section 2.4.4. Because of the proximity of the wells within a cluster, it will be unnecessary to sample and describe the lithology of each borehole during the installation of each well in a cluster. Therefore, the glacial materials in only one borehole of each well cluster will be sampled and described in detail. Installation of wells in glacial deposits will occur after installation of bedrock wells at MW-1 through MW-6 is complete.

All drilling and well installation will be supervised and documented by qualified WWES personnel. Documentation will be recorded on boring log forms in accordance with WWES' "Field Notes/Records" and "Well/Boring Log Guidelines" SOP's. All drilling equipment including the drilling rig, augers, tools, and other necessary materials will be washed or steam cleaned between each borehole in accordance with WWES' "Decontamination, Downhole Sampling Equipment" SOP. Hexane, acetone, and/or methanol will only be used if visible oil or dirt cannot be removed from the sampling equipment by conventional steam cleaning or washing techniques. This will reduce the possibility of introducing VOCs into a sample. The use of hexane, acetone or methanol will be documented on the boring log.

All monitoring wells will be constructed of 2-inch diameter PVC riser pipe and screens with flush joint threads. The use of PVC for well materials will allow electromagnetic geophysical logging of any well to evaluate ground water quality as described in Section 2.4.2.4. Threaded joints between sections of casing will be wrapped with Teflon tape to eliminate leakage at the threads. The screens will have 0.010-inch (10-slot) factory prepared slots. A threaded PVC cap will be installed on the bottom of each well screen. Prior to installation of each well, all well construction materials will be steam cleaned to the satisfaction of WWES personnel.

A sand pack of clean silica sand shall be placed in the screened interval and extend to at least 2 feet and not more than 3 feet above the top of the well screen. A 2 to 3-foot thick seal of granular or pelletized bentonite will be emplaced immediately above the top of the sand pack to ensure that a competent seal is in place. A cement/bentonite grout will be tremied from the bentonite seal to just below ground surface to ensure that the annular space between the well and borehole has been completely sealed. A locking, steel, protective casing will be installed at the ground surface secured in concrete. Steel bumper posts may be installed surrounding any well that appears to be in a traffic zone. All borehole drilling and well construction details will be recorded by WWES personnel in a bound field logbook or on boring log and well installation data sheets. A schematic diagram of construction details for monitoring wells in glacial deposits and monitoring wells in bedrock is shown in Figures 5 and 6, respectively.

Each of the monitoring wells will be developed no earlier than 24 hours after installation. Well development will be done by a method which will result in surging and pumping water back and forth through the well screen in accordance with WWES' "Monitoring Well Purging With a Bladder, Keck, or Electric Submersible Pump" or "Monitoring Well Purging with a Suction Ditch Pump" SOPs. The wells will be developed until at least 3 to 5 well volumes have been evacuated and pH, temperature, and specific conductivity measurements have stabilized to within 10 percent for two successive well volumes. The pH and conductivity in each sample will be measured in accordance with WWES' "Standard Operating Procedure for Field Determination of pH" and "Standard Operating Procedure for Field Determination of Conductivity, Method 205" SOPs, respectively. Well volumes will be calculated in accordance with WWES' "Well Casing Volume Calculation" SOP. Purged water will be containerized in 55-gallon drums for storage until the ground water analytical results can be reviewed. The drums will be labeled according to which well the water was collected and stored within a secured area until their ultimate fate can be determined. All details concerning well development including date, time, method and amount of water evacuated will be recorded by WWES personnel in a bound field logbook or on well data sheets.

During Phase II of this RI, as many as 12 contingency wells (5 in the glacial materials, 5 in the shallow bedrock, and 2 deep bedrock) may be drilled for plume definition purposes at locations to be determined based on results of the Phase I investigations. Twelve contingency wells have been budgeted for this purpose. These wells will only be installed if approved by the U.S. EPA RPM and authorized by the U.S. EPA Contracting Officer.

2.4.2.1 Monitoring Wells in Glacial Deposits

Only 1 well is proposed at each of the 4 locations adjacent to the North Branch of the Kalamazoo River since each lies within a wetland area and the water table is anticipated to be shallow in this area.

One monitoring well will be installed at each of the 4 locations in the wetlands along the North Branch of the Kalamazoo River. Each of these wells will have a 3-foot long screen which will be installed approximately 2 feet below the water table. These wells will be installed in hand-augered boreholes. Since ground water at these locations is anticipated to be near the ground surface, and at times, exhibit artesian conditions, each of these well casings will be equipped with packer inside the casing. The packer will provide a means of depressing, and holding, the ground water level below the frost line during the winter to prevent the water from freezing and potentially cracking the well casing.

All other monitoring wells installed in the glacial deposits will be installed through hollow stem augers in accordance with the methods described in WWES' "Installation of Permanent Monitoring Wells with Hollow Stem Augers" SOP. The minimum inside diameter of the hollow stem augers will be 4.25 inches. Except at the wetland locations discussed above, it is anticipated that 2 monitoring wells with 5-foot long screens will be installed in the glacial deposits at each location. One monitoring well will be installed with the top of the screen set approximately 2 feet below the water table, and 1 will be installed with the base of the screen immediately above the top of bedrock. If the glacial aquifer is no more than 15 feet thick, only 1 monitoring well will be set in the glacial deposits. Placement of the screens in the glacial aquifer may also depend on results of the downhole geophysics and the vertical ground water sampling.

2.4.2.2 Monitoring Wells in Bedrock

The top of the screen in all bedrock wells, except the deep well at the downgradient location (MW-6), will be installed approximately 10 feet below the top of the unweathered bedrock. The screens in all bedrock wells will be 5 feet long. The screen at the downgradient location will be set in the second 10-foot interval of bedrock in which no evidence of contamination is observed, in the field, as described in Section 2.4.4.3.

The glacial materials at each bedrock well will be cased with 6-inch diameter PVC set through 8.25-inch hollow stem augers in essentially the same manner as described in Section 2.4.2.1 for installing wells through hollow stem augers. The casing will extend 2 feet below the base of the unweathered bedrock. A packer will be installed on the bottom of the casing to aid in sealing the annular space between the casing and the borehole with a cement/bentonite grout. The cement/bentonite grout will be allowed to set for a minimum of 24 hours before drilling activities resume.

At the first 6 bedrock locations drilled, the bedrock will be cored using air rotary drilling techniques as described in Section 2.4.2.3. Upon completion of coring, the boreholes will be reamed to approximately 6 inches in diameter then flushed with water to clean the borehole prior to installing the well. Air rotary techniques will be used to drill the 6-inch diameter boreholes for each of the remaining bedrock wells. Two-inch diameter PVC wells will then be installed in each borehole. Essentially all other well installation details will be as described in Section 2.4.2.1 for installing wells through hollow stem augers.

The compressed air used for drilling will be filtered to prevent the introduction of water, oils, or any other foreign substance downhole and into the subsurface.

2.4.2.3 Bedrock Coring

Cores will initially be collected in 5-foot intervals. Coring intervals may be increased to 10 feet if core recovery is consistently greater than 95 percent. Core samples will allow for examination of consolidated rock samples which will aid in defining lithologic and physical characteristics of the bedrock. The presence of bedding, joints, fractures, and other structural features of the bedrock will be documented. The depths and character of each stratum encountered in the borehole will be recorded, along with notations of other visually apparent features such as fractures, joints and other physical features, on the well/boring log.

The core samples will be placed in order of collection, from top to bottom, in wooden boxes for storage on-site. The top and bottom of each core will be labeled at the time of collection and spacers marked with sample depths will be placed between each core sample. Samples in each core box will be photographed.

2.4.2.4 Downhole Geophysical Logging

A suite of geophysical logs will be run in PVC-cased wells penetrating shallow bedrock at locations MW-1 through MW-5 and in the deep bedrock well at location MW-6 (see Figure 3). The suite will include natural gamma and EM conductivity logs which will be used to delineate lithology and to evaluate ground water quality.

The gamma log measurements will be made in accordance with WWES' "Borehole Geophysical Logging (Gamma)" SOP using a Keck SR-3000 Borehole Logger (or equivalent) designed to detect gamma radiation emitted primarily from the isotope potassium-40. These natural emissions are indicative of relative clay content and will allow identification of clay layers or clayey zones which may affect ground water flow and thus contaminant migration pathways. Time constant and logging speed will be selected to provide vertical resolution on the order of 0.5-foot.

A Geonics EM-39 Borehole Logger (or equivalent) will be used to measure vertical variations in pore fluid conductivity at a distance of 12-inches from the borehole axis. The EM conductivity logs will be obtained in accordance with WWES' "Borehole Geophysical Logging (EM-Induction)" SOP. This data will allow vertical definition of a conductive contaminant plume, if present. These data, collected from the bedrock wells, can be used to determine the appropriate screen depth for the monitoring wells set in the glacial deposits.

2.4.3 GROUND WATER FLOW CHARACTERISTICS

2.4.3.1 Aquifer Tests

An *in situ* hydraulic conductivity test (slug test) will be performed on each monitoring well installed during Phase I of the RI in accordance with WWES' "Slug Tests" SOP. Data obtained from the slug test will be evaluated using the computer program AQTESOLV based on Bouwer and Rice, 1976, Bouwer 1989, and Cooper, Bredehaft, and Papadopulos, 1967.

In situ hydraulic conductivity tests (packer tests) will be performed in the bedrock corehole at the downgradient monitoring well location (MW-6). The packer tests will be performed on the entire cored interval and the tests and data evaluation will be performed in accordance with methods described in Test Designation E-18 of the Earth Manual (Bureau of Reclamation, 1974). This test method is provided in Appendix C.

The packer tests will be performed in 10-foot intervals from the bottom of the borehole to the top of bedrock. If the hydraulic conductivity within a test interval is too high to obtain meaningful data, the test may be rerun in that zone in 5-foot intervals. The packers will be inflated with nitrogen gas to eliminate the potential for influencing subsurface chemistry if a leak were to develop in the supply line or packers.

If results of other field investigations conducted during this RI do not define the degree of communication between the glacial and bedrock aquifers, it may be necessary to perform a pump test on one or both of the aquifers. The necessity of a pumping test as well as the pumping test design and analysis, will be determined with concurrence of the U.S. EPA in consultation with the MDNR.

2.4.3.2 Ground Water Flow Direction

On 3 occasions prior to completing modeling described in Section 2.4.3.3, ground water level measurements will be taken in each of the monitoring wells installed during Phase I of this RI in accordance with WWES' "Water Level Measurements" SOP. Surface water elevation measurements will also be taken on each occasion at staff gauges installed both upstream and downstream from the site in the North Branch of the Kalamazoo River. Water levels will be measured in all wells within a 24-hour period on each occasion. The rounds of water levels will be separated by a minimum period of four weeks.

Surface water flow in the North Branch of the Kalamazoo River will also be measured during the first and third water level measuring occasions. River flow measurements will be taken in accordance with WWES' "Surface Water Flow Measurements" SOP.

Water levels and surface water flow measurements will aid in defining ground water flow characteristics beneath the site and in assessing the hydraulic connection between the glacial and bedrock aquifers, and the North Branch of the Kalamazoo River. These measurements will also aid in accurately calibrating ground water models used during this RI to site specific conditions. Water level measurements will be taken on a monthly basis throughout the initial year of the RI/FS.

2.4.3.3 Ground Water Modeling

It is anticipated that ground water flow modeling will be necessary in order to evaluate the potential remedial options, ground water flow patterns, and exposure routes at the site.

To achieve these objectives, we anticipate using a three-dimensional flow model finite-difference computer code developed by the U.S. Geological Survey entitled MODFLOW. Various preprocessors and post-processors will be applied in conjunction with MODFLOW. The modeling will be conducted in accordance with WWES' "Numerical Ground Water Modeling" SOP. The numerical model will incorporate the site hydrogeology determined by results of the field investigations to mathematically represent flow within the aquifers and the hydraulic communication with the North Branch of the Kalamazoo River.

The integrity of the model will be assured by calibrating the modeled water levels with the actual water levels measured at monitoring wells in the field. Calibration will consist of adjusting the hydraulic parameter values that are input into the ground water model. Reasonable ranges for the hydraulic conductivity of distinct units, the rate of recharge, and the riverbed conductance will be established on the basis of the geologic environment and the data collected. Within the stated range, the value of input parameters will be varied until a combination is attained that minimizes the difference between the modeled and actual values of water levels. The calibration will be performed on the set of observed water levels that best approximate average conditions.

Once calibration has been completed, the output of the numerical model (nodal values for hydraulic head) will be combined with hydraulic conductivity values and boundary conditions to determine expected flow lines and times of travel.

The model will have the capacity to test the effect of potential remedial options (for example, recovery wells, trenches, slurry walls) and if ground water treatment includes purging, to provide estimates of the time required for different constituents of concern.

2.4.4 GROUND WATER SAMPLING

2.4.4.1 Ground Water Sampling Locations and Parameters

Two ground water samples will be collected at each monitoring well in order to evaluate the impact of the landfill on the aquifers beneath the site. The proposed monitoring well locations are illustrated in Figure 3. The monitoring wells will be installed as described in Section 2.4.2. Installation and development activities will be completed at least 72 hours before ground water sampling activities commence at each well. Up to 37 monitoring wells may be installed and sampled at the site.

Ground water samples will be collected on 2 occasions from each monitoring well and submitted for chemical analyses as summarized in Table 6. The results of the first set of analyses will be evaluated to determine which samples from the second set should be submitted using the low detection limit residential well Special Analytical Services (SAS) request. Ground water which, based on the first analytical set, has very low or detectable levels of Target Compound List (TCL) organics and TAL inorganics, will be selected for the SAS analysis during the second set of analyses. This will allow for screening for compounds at lower detection limits to achieve compliance with Michigan Act 307 detection limit requirements.

2.4.4.2 Ground Water Sampling and Equipment Procedures

Ground water samples will be collected using a Teflon bailer following WWES' "Monitoring Well Sampling with a Bailer" SOP. To prevent the loss of contaminants while sampling, a bottom-emptying device will be utilized on the bailer when collecting samples to be analyzed for organics. Shallow monitoring wells will be purged prior to sampling with a clean Teflon bailer. In the deeper monitoring wells, purging prior to sampling with the bailer will be accomplished using a Keck pump following WWES' "Monitoring Well Purging with a Bladder, Keck, or Electric Submersible Pump" SOP. All wells will be purged of at least 3 casing volumes prior to sampling. Upon completion of purging, the temperature, pH, specific conductivity, and Eh of each sample will be measured. Measurements of the pH, specific conductivity, and Eh of each sample will be measured in accordance with WWES' "Field Determination of pH", "Field Determination of Specific Conductivity, Method 205", and "Field Determination of Oxidation/Reduction Potential (Eh)" SOPs, respectively. Samples collected for analysis of TAL metals will be filtered at the time of collection using a 0.45-micron membrane filter. Samples collected for analysis of TAL cyanide will not be filtered. All sampling equipment will be decontaminated between use following WWES' "Decontamination Down-hole Sampling Equipment" SOP.

2.4.4.3 Vertical Ground Water Sampling

Ground water samples will be collected from the bedrock aquifer during coring of the deep bedrock well (MW-6) at the downgradient location. Samples will be collected for each 10-foot interval cored. After a 10-foot interval of rock has been cored, that section of bedrock will be isolated by using a packer at the top of the interval. At least three 10-foot corehole volumes will be purged from the sampling interval prior to sample collection. Specific conductivity, temperature, and pH will be measured periodically while purging to document that these parameters have stabilized prior to collecting a sample. Measurements of the pH, Eh, temperature, and specific conductivity will be taken, and a scan for volatile organic compounds listed in Table 7 will be performed with a gas chromatograph (GC) at the time each sample is collected. If the field measurements or GC scan indicate evidence of contamination is present, coring will continue. If no contamination is detected with these field analyses in 2 successive 10-foot rock intervals, or the corehole has been sampled to a depth of 120 feet, coring will cease and a well will be set as described in Section 2.4.2.2.

Ground water samples will be collected at 5-foot intervals while drilling through glacial deposits at 3 locations, (MW-3, MW-4, and MW-6) during installation of the 6 initial bedrock monitoring wells. Sampling will be accomplished through temporary monitoring wells in accordance with WWES' "Temporary Wells Through Hollow Stem Augers" SOP.

Measurements of pH, Eh, temperature, and specific conductivity will be taken in the field, and a field scan for VOCs will be performed with a GC at the time each sample is collected. The field scan for VOCs will include the parameters listed in Table 7. Scanning will be performed in accordance with WWES' "Field Analyses for Volatile Organics in Ground Water" SOP.

2.5 SURFACE WATER INVESTIGATIONS

Twelve surface water samples will be collected from the North Branch of the Kalamazoo River. Six samples (3 pairs) will be collected from areas downstream of the site and six samples (3 pairs) will be collected from upstream areas. Eight surface water samples will be collected from wetland areas adjacent to the river, 4 from upstream wetlands and 4 from downstream wetlands. Four surface water samples will also be collected (if possible) from wetlands north of Erie Road. These surface water sampling locations are shown on Figure 7. The locations of these samples may be revised following review of the ground water flow direction.

Surface water samples from the river will be collected in midstream/nearshore pairs. The midstream location is identified as one-half the shortest transect of the stream at the sampling location. The nearshore location is identified as 2 feet from the left bank of the river (facing upstream) along the same transect. The locations of these transects are presented in Figure 7. The nearshore samples will be collected from depths 1 foot below the surface, unless the water is found to be less than 1.5 feet in depth. In this case, the sample will be collected from the depth one-half the distance from the surface to bottom. Samples from midstream will be collected from a depth equal to 60% of the total depth at the sample location. Samples will be collected directly into the sampling bottle. In shallow water, the samples will be collected by a field technician wearing waders and shoulder length gloves. The technician will stand downstream of the station and collect the sample to the upstream side. If deeper water is encountered, it may be necessary to collect samples from a boat. Both unfiltered and filtered surface water samples will be collected for TAL metals analysis. Surface water samples for TAL cyanide analysis will not be filtered. A 0.45 micron membrane filter will be used to filter the samples. Surface water samples will be collected in accordance with WWES' "Surface Water Sampling" SOP.

River water samples will be collected beginning at the furthest downstream station and proceeding upstream. Samples will be collected on a day when the stream level is in static conditions (neither rising or falling significantly) and at least 48-hours following the last precipitation event. All surface water samples will be collected on the same day to minimize effects due to changing water conditions.

Just prior to river water sampling, river flow measurements will be taken at the Twenty-nine and One-Half Mile Road bridge, approximately 0.5 miles downstream of the site. River flow will be measured in accordance with WWES' "Surface Water Flow Measurements" SOP.

Surface water samples in wetlands will be collected at depths midway between the water surface and bottom. Samples will be collected directly into the sampling bottle. In the case of VOCs, the VOC vial will be pre-preserved. The sample will be collected by a field technician wearing waders and shoulder length gloves.

Duplicate samples and deionized water trip blanks will also be prepared and submitted for laboratory analysis. One duplicate sample will be submitted for every 10 investigative samples. Trip blank samples will accompany each cooler containing VOC samples.

At each river and wetland sampling location, field measurements of pH, dissolved oxygen, specific conductivity, Eh, and temperature will be taken. These WWES SOPs are included in Appendix A. Table 8 summarizes the maximum estimated number of samples submitted and DQO for each chemical analysis.

2.6 SEDIMENT INVESTIGATIONS

Twelve sediment samples will be collected from the North Branch of the Kalamazoo River. These will be collected from the same locations as surface water (i.e., 6 samples will be collected upstream and 6 samples will be collected downstream of the site). These samples will also be collected in midstream/nearshore pairs. Midstream and nearshore samples will be identified as discussed for surface water above. Eight additional sediment samples will be collected from the wetland areas adjacent to upstream and downstream areas of the river. In addition, four sediment samples from wetland areas north of Erie Road, west and east of the site, will also be collected. The proposed sampling locations are shown in Figure 7. It may be necessary to move the stations slightly from these indicated positions depending on field conditions.

Sediment samples will be collected from the river using a Petite Ponar sampler. In shallow water, the sampler will wade to the sampling point. If deeper water is encountered, it may be necessary to collect samples from a boat. In either case, samples will be collected beginning with the downstream locations and proceeding to upstream sampling locations. Sediment samples from the river will not be collected on the same day as surface water samples. The samples for VOCs will not be composited in order to prevent the loss of volatiles. All other samples will be composited in a stainless steel bowl using a stainless steel spatula.

Sediment samples will be collected from wetland areas using either a stainless steel shovel or a Petite Ponar sampler. In wetlands, surface water and sediment samples will be collected at each station during the same visit (the surface water sample will be collected first followed by the sediment sample). Sediment samples will be collected from the top 0 to 12 inches of sediment beneath any vegetative mat. Sediment clinging to the mat will be scrapped off into the area to be sampled. Table 9 summarizes the maximum estimated number of samples submitted and DQO for each chemical analysis. Any free water on top of the sediment samples will be decanted from the sample before the sample is placed in sample containers.

Duplicate samples and trip blanks (deionized water blanks) will also be prepared and submitted for laboratory analysis. One duplicate sample will be prepared for every 10 investigative samples. Trip blank samples will accompany each cooler containing VOC samples.

A specific description of standard sediment sampling procedures to be used is documented in WWES' "Surficial Sediment Sampling" SOP.

2.7 RESIDENTIAL WELL SAMPLING

2.7.1 SAMPLE LOCATIONS AND ANALYSES

Up to 20 private wells will be sampled in the area surrounding the Albion-Sheridan Township Landfill. The selection of individual wells to be sampled will be dependent on the ground water flow direction and the proximity of the wells to the Albion-Sheridan Township Landfill.

Duplicate samples and deionized water trip blanks, will also be prepared and submitted for laboratory analysis. Trip blank samples will accompany each cooler containing VOC samples.

2.7.2 SAMPLING EQUIPMENT AND PROCEDURES

U.S. EPA, MDNR, and/or Calhoun County will assist WWES in obtaining permission and scheduling the sample collection. The samples will be collected according to WWES' "Sampling Ground Water from a Domestic Well" SOP. The SOP specifies that samples be collected directly from a tap that intercepts the water system prior to any treatment, such as a water softening unit. The water will be allowed to run for at least 15 minutes to ensure that the pipes have been adequately flushed. The flow will be measured and recorded. The water samples will be collected directly from the tap into the appropriate sample bottles. Water will be introduced slowly into VOC vials to reduce splashing and volatilization. Samples will not be field filtered.

Field measurements for the water samples that will be recorded in a logbook or on field data sheets include; pH, Eh, specific conductivity, and temperature. Additional data that will also be noted include; color of sample, any odors, amount of time the pipes were flushed, details concerning well system, piping and proximity to septic system. Table 10 summarizes the maximum estimated number of samples submitted and DQO for each chemical analyses.

2.8 SURFACE SOIL INVESTIGATION

2.8.1 SAMPLING LOCATIONS AND ANALYSIS

Surface soil (0 to 6 inches) will be collected at several locations in and around the landfill to evaluate surface soil contamination.

An estimated 12 to 16 surface soil samples will be collected at areas of special concern. These areas will include the former refuse transfer station on the north side of the site, areas where drums were previously located, the ORV area west of the site, and the residential area and garden on the southern portion of the site. The selection of the exact locations for these samples will be based on visual observations, including, but not limited to, soil staining and noticeable odors. Sampling locations will be approved by the U.S. EPA.

Background surface soil samples will be collected from 4 sampling locations for each surface soil type identified in on-site sampling. In identifying suitable background sampling locations, areas unaffected by the site (upgradient and upwind) will be selected. This is most likely to be an area north of the site. The area selected for background sample collection will be located at least 100 feet from any roads, roadsides, parking lots, railroads, storm drains or areas visibly appearing to be affected by the site.

Duplicate samples and deionized water trip blanks will also be prepared and submitted for laboratory analysis. Trip blank samples will accompany each cooler containing VOC samples.

2.8.2 SAMPLING EQUIPMENT AND PROCEDURES

The samples will be collected using a decontaminated stainless steel spatula, hand auger, or trowel. The soil will be immediately transferred into the appropriate jars to reduce the loss of VOCs. The remaining soil will be mixed and then will be transferred to the appropriate sample container. The samples will be collected from between 0 to 6 inches below the ground surface. The specific area in which the samples will be collected will be determined in the field after examination of current field conditions. The samples for VOCs will not be composited in order to prevent the loss of volatiles. All other samples will be composited in a stainless steel bowl using a stainless steel spatula. The surface soil sampling equipment will be decontaminated with an alconox or TSP wash solution, a rinse of tap water, and a final rinse in distilled water between each sample. Hexane will only be used if visible oil or dirt cannot be removed by conventional decontamination techniques. This will reduce the possibility of introducing volatile contaminants into the sample. The samples will be visually described and scanned with an PID and/or FID.

All details concerning the surface soil samples will be documented in a bound field logbook or field data sheets. The sampling locations will be tied into the site grid.

A specific description of standard surface soil sampling procedures is presented in WWES' "Grab Samples of Surface Soils" SOP. Surface soil samples will be analyzed for the list of analytes presented in Table 11.

2.9 ECOLOGICAL INVESTIGATIONS

Biological and ecological information will be collected at the site and used as part of the Baseline Risk Assessment. Information for this assessment will be derived from a combination of existing information and RI field investigations. Phase I and potential Phase II activities are described below.

2.9.1 PHASE I ECOLOGICAL ASSESSMENT

The Phase I Ecological Assessment will include an evaluation of the following: previously collected regional information on habitats and species of concern; recorded observances of terrestrial species on the site during RI activities; identification of dominant plants and plant communities; and media-specific data collected during the sediment, surface water, and ground water investigations.

To identify the habitats and species of concern, the MDNR and the U.S. Fish and Wildlife Service will be contacted in writing and requested to provide information from past surveys in the area. This will include information from the Michigan Natural Features Inventory concerning threatened and endangered species. To further document species of concern, a record of terrestrial animals observed on-site during the RI will be maintained. This record will be kept during three distinct investigation phases which include: the wetland sampling event, the surface water sampling event, and the surface soil sampling event. In addition, dominant plant species and communities and potential areas of floral stress at the site will be recorded.

A toxicity assessment will combine information on habitats and species of concern with the results of sampling of the various environmental media. The toxic impacts of site related chemicals on the nearby river will be estimated by comparing surface water and sediment concentrations to available surface water and sediment criteria. This assessment may also utilize the site ground water model to estimate contaminant loads to the river under reasonable worst case conditions. These predicted concentrations would then also be compared to available surface water and sediment quality criteria.

2.9.2 PHASE II ECOLOGICAL ASSESSMENT

The above information will be summarized in a Preliminary Ecological Investigation Report. This document will be sent to U.S. EPA for review and comments on this document and will be used as the basis for potential Phase II ecological sampling. If the preliminary investigation warrants, Phase II biological sampling will be conducted. A possible focus of Phase II biological sampling would be benthic macroinvertebrates in the nearby river. Other potential tasks may include aquatic or sediment, chronic or acute toxicity testing, bioaccumulation studies, or community studies. This work will only be performed if approved by the U.S. EPA RPM and authorized by the U.S. EPA Contracting Officer.

2.10 AIR MODELING (OPTIONAL)

If determined to be necessary based on the results of other site investigations, several U.S. EPA-approved predictive models, including CHEMDAT7, BOXMOD, and ISCST, may be used to estimate concentrations of chemicals in the ambient air on and near the site. This work will only be performed if approved by the U.S. EPA RPM and authorized by the U.S. EPA Contracting Officer. Air modeling will be conducted to support the analyses contained in the Baseline Risk Assessment for the site. Direct monitoring of air contaminants will not be conducted during the Phase I investigation.

The predictive models to be employed require information on source areas (contaminated soils) presented in square grids. Contaminant soil concentrations and soil characteristics in source areas to be used in the air modeling will be determined from the surface and subsurface soil investigations described in Sections 2.4.1 and 2.8 of this plan. Model inputs will be based on soil samples collected from all depths within specific source areas. Meteorological data, including wind speed and direction, are inputs to these models and will be obtained from the nearest National Weather Service (NWS) air monitoring stations

(Jackson or Battle Creek, Michigan). Physical data for modeled chemicals will be obtained through databases developed by U.S. EPA for use in the above models.

2.11 SOIL VAPOR SURVEY (OPTIONAL)

2.11.1 SOIL VAPOR SAMPLE LOCATIONS

If results of other field activities of the RI deem that it is appropriate, a soil vapor survey will be conducted at the site. This work will only be performed if approved by the U.S. EPA RPM and authorized by the U.S. EPA Contracting Officer. A soil vapor survey may aid in 1) determining the organic composition of the soil vapor; 2) locating potential source areas for volatile organic compounds (VOCs) within the landfill; and 3) delineating the horizontal extent of VOCs within the unsaturated zone at the site.

The decision on the necessity and objectives for a soil vapor survey will be made with direction from the U.S. EPA. Details such as the number of sample locations, appropriate sampling depths and sampling location selections will be determined once an objective has been defined.

Any soil vapor samples collected will be analyzed for the volatile organic compounds identified in Table 7. All analyses will be performed in the field using a Hewlett Packard 5890A GC or equivalent. The analysis will be conducted according to WWES' "Field Analyses of Soil Vapor for Volatile Organic Compounds" SOP. Any deviations from these SOPs will be documented in the field notes and evaluated during the interpretation of the results. The DQO for the analyses is a Level II.

2.11.2 SOIL VAPOR SAMPLING PROCEDURES

If a soil vapor survey is conducted, a decontaminated, heavy-duty alloy steel soil vapor probe, with a stainless steel mini-well casing will be installed at each sampling location using a hydraulic probe driving unit. The mini-well casing will be decontaminated by first brushing off any visible dirt with a stiff wire brush, the casing will then be steam cleaned, securely wrapped in clean plastic, and then stored away from possible contaminants until needed at a sampling location. Prior to sample collection, the probe will be purged with a low volume air pump until 3 times the volume of the soil vapor probe is evacuated from the probe. The air pump will be calibrated in accordance with the procedures documented in Appendix D. While the probe is being purged, VOC readings will be made with a photoionization detector (PID) and/or flame ionization detector (FID) for health and safety purposes and to assess if the total organic vapor concentration of the soil vapor changes with time. After purging, the soil vapor samples will be collected into a Tedlar bag.

The Tedlar bag will be filled by connecting the bag with a Teflon-lined sampling liner to the soil vapor probe and inducing a vacuum on the exterior of the bag, which will directly draw the soil vapor into the bag as illustrated in Figure 8. The Tedlar bag will be used to directly inject the sample into a Hewlett Packard-GC, located on-site. The Hewlett Packard-GC will be operated in accordance with WWES' "Field Analysis of Soil Vapor for Volatile Organics Compounds" SOP.

3.0 FEASIBILITY STUDY

3.1 PURPOSE

The purpose of the Feasibility Study is to develop remedial alternatives which are protective of human health and the environment. The FS will conform to the requirements of CERCLA and SARA, as amended, the National Contingency Plan (NCP), as amended, the RI/FS Guidance for CERCLA Municipal Landfill Sites (February 1991), and U.S. EPA policy. This Work Plan describes the technical approach to the FS and lists preliminary potential remediation technologies which will be screened and evaluated. The criteria to be used to screen and evaluate the remedial action alternatives will also be discussed. Remedial investigation activities which will be implemented under this Work Plan will provide the site characterization data required to develop and screen remediation alternatives. The remediation alternatives may address surface controls, source control for municipal waste and hot spots, treatment of wastes and impacted media, off-site disposal, and combinations thereof.

3.2 SCOPE

The FS will consist of 3 tasks:

- Remedial Alternatives Development and Screening (Section 3.3.1);
- Detailed Analysis of Alternatives (Section 3.3.2); and
- Feasibility Study Report (Section 3.3.3).

The Work Plan to accomplish each task is described below.

3.3 FEASIBILITY STUDY TASKS

3.3.1 REMEDIAL ALTERNATIVES DEVELOPMENT AND SCREENING

The primary objective of this task is to develop remedial alternatives that are protective of human health and the environment for additional screening and evaluation. A preliminary list of potentially feasible technologies has been developed during project planning. This preliminary list of alternatives may be subsequently modified or refined during later FS phases as additional information on site conditions becomes available. This task is comprised of 5 subtasks, which are described below.

3.3.1.1 Preliminary Remediation Technologies

A comprehensive list of feasible remediation technologies will be prepared according to site conditions and contaminant types and concentrations. This list will be screened to eliminate or modify technologies which will be very difficult to implement, very time-intensive, or which rely on unproven technology. Appropriate innovative technologies in the U.S. EPA Superfund Innovative Technology Evaluation (SITE) program for which information is available will be included on the master list. Table 2 is a preliminary list of potentially feasible technologies. Technologies on this list will be screened during the RI/FS. Criteria for technology screening are described below. The identified technologies will be evaluated to determine:

- The potential effectiveness of the technology in handling the estimated areas or volumes of media;
- The effectiveness of the technology in protecting human health and the environment during the construction and implementation phase; and
- The reliability of the technology with respect to site-specific conditions.

The institutional implementability of the identified technologies will be evaluated to determine if a proposed technology may be unworkable. Factors evaluated will include:

- Ability to obtain necessary permits for off-site actions;
- The availability of treatment, storage, and disposal services; and
- The availability of necessary equipment and skilled workers to implement the technology.

Cost plays a limited role in the preliminary screening of technologies. Relative capital and operations and maintenance (O&M) costs will be used rather than detailed estimates. The cost analysis will be based on engineering judgement and each technology will be evaluated as to whether the cost is high, medium, or low as compared to other technologies.

In addition, U.S. EPA expectations listed in the NCP which relate to practicable remedial alternatives and streamlining the RI/FS process will be considered in the technology screening. The results of this subtask will be summarized in a Preliminary Remediation

Technologies Technical Memorandum for submittal to the U.S. EPA and the MDNR. Technologies which are carried through this screening will be described after remediation alternatives are assembled and screened.

3.3.1.2 Development of Alternatives

Remedial action objectives will be developed which specify the contaminants and media of interest, exposure pathways, and remediation goals. These objectives will be based on contaminant-specific ARARs, when available, and PRGs. Guidance used to develop these objectives will include Section 300.430(e) of the NCP, U.S. EPA's RI/FS Guidance for CERCLA Municipal Landfill Sites, and the requirements of other applicable federal and state environmental standards, guidance, and advisories as defined under CERCLA, Section 121. As more site data become available during the RI, the PRGs, and consequently the remedial action objectives, will be modified.

Objectives for source control measures will be developed to prevent or significantly minimize migration of contamination from the site. Objectives for off-site measures will be developed to prevent or minimize the significant impacts of contamination that has migrated from the site. Preliminary cleanup objectives will be developed in consultation with the U.S. EPA and the MDNR.

General response actions are medium-specific actions that will satisfy remedial action objectives. General response actions will be defined and refined throughout the RI/FS as a better understanding of the site is obtained and ARARs are identified. Alternatives for implementing general response actions will be prepared considering the expectations of the NCP, as described in the RI/FS Guidance for CERCLA Municipal Landfill Sites. The NCP expectations listed therein are summarized below:

- The principal threats posed by a site will be treated whenever practical.

- Engineering controls such as containment will be used for waste that poses a relatively low long-term threat or where treatment is impractical.

- A combination of methods will be used as appropriate to achieve protection of human health and the environment.

- Institutional controls will be used to supplement engineering controls, as appropriate, to prevent exposure to hazardous wastes.

- Innovative technologies will be considered when such technologies offer the potential for superior treatment performance or lower costs for performance similar to that of demonstrated technologies.

- Ground water will be returned to beneficial uses whenever practical.

In order to streamline identification, evaluation and selection of a remediation alternative in accordance with the expectations of the NCP, the following items, listed in the municipal landfill guidance, will be considered:

- Generally, the most practicable remedial alternative for landfills is containment.

- Treatment of soils and wastes may be practicable for hot spots. Consolidation of hot spot materials under a landfill cap is a potential alternative in cases when treatment is not practicable or necessary.

- Extraction and treatment of contaminated ground water and leachate may be required to control off-site migration of wastes. Additionally, extraction and treatment of leachate from landfill contents may be required. Collection and treatment may be necessary indefinitely because of continued contaminant loadings from the landfill.

- Constructing an active landfill gas collection and treatment system should be considered where existing or planned homes or buildings may be adversely affected through either explosion or inhalation hazards; final use of the site includes allowing public access; the landfill produces excessive odors; or it is necessary to comply with ARARs. Most landfills will require at least a passive gas collection system to prevent buildup of pressure below the cap and to prevent damage to the vegetative cover.

The alternatives developed may overlap in some areas. Further, alternatives outside of the above categories may also be developed. As required by the NCP, a No Action Alternative will be carried through the alternatives evaluation. The alternatives will be developed in close consultation with the U.S. EPA and the MDNR. The rationale for excluding any remedial action technology identified earlier will be documented in the development of alternatives.

3.3.1.3 Initial Screening of Alternatives

The objective of this subtask is to eliminate from the list of potential alternatives those alternatives which clearly are impractical, ineffective, or redundant. Alternatives carried through this screening will be evaluated in detail (see Section 3.3.2). This initial screening is intended to comply with the U.S. EPA's goal of streamlining RI/FS for CERCLA municipal landfill sites. During the initial phase of the remedial alternatives development and screening, specific technologies will be evaluated against specific remedial action objectives. During alternative screening, the entire alternative will be evaluated based on its effectiveness, implementability, and cost. These screening considerations are described below.

Only those reliable alternatives that satisfy the response objectives and protect human health and the environment will be considered further. Alternatives posing significant adverse environmental effects will be excluded. Other measures of effectiveness are the degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risks and affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection.

Alternatives that may prove extremely difficult to implement either technically or administratively, or require equipment, specialists or facilities that are not available within a reasonable period of time, will be modified or eliminated.

An alternative whose cost far exceeds that of other alternatives will usually be eliminated unless significant benefits may also be realized. However, costs will not be used to compare treatment and non-treatment alternatives. The cost screening will be conducted only after the environmental and public health screening have been performed. Total costs will include order-of-magnitude estimates of the costs of implementing the alternatives and the costs of operation and maintenance.

Innovative technologies which may offer superior performance, fewer adverse environmental impacts, or lower costs than comparable demonstrated technologies will be carried through the screening to detailed evaluation. The containment and no-action alternatives will also be carried through to the detailed evaluation.

3.3.1.4 Remedial Alternatives Array Document

The remedial alternatives must meet ARARs as required by CERCLA Section 121. A remedial Alternatives Array Document (AAD) will be prepared and submitted to the U.S. EPA and the MDNR. Included in this document will be a brief history and site background and a site characterization indicating contaminants, pathways, and receptors, and other pertinent site features. The results of alternatives development and screening will be summarized in the AAD for comparison.

The intent of submitting the AAD to the U.S. EPA and the MDNR is to solicit focused input regarding chemical-, location-, and action-specific requirements for the particular conditions and alternatives described in the AAD. The responses to the AAD will be reviewed to determine the site specific requirements for each alternative. Comments on the AAD will be incorporated into the FS Report.

3.3.1.5 Data Requirements

Data related to the remedial alternatives which are required for detailed evaluation of the alternatives will be identified. This will allow data gaps in the FS to be identified prior to the detailed evaluation.

3.3.2 REMEDIAL ALTERNATIVES EVALUATION

Each alternative will be evaluated on a technical, environmental, public health, institutional, and cost basis. The alternatives will then be compared based on several criteria and ranked such that the most cost-effective alternative meeting all criteria is identified.

3.3.2.1 Remedial Alternative Detailed Analysis

The alternatives that remain after completion of the remedial alternatives development and screening will be subjected to a detailed analysis. The analysis will take into account overall protection of human health and the environment; ARAR compliance; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; state acceptance; and community acceptance. For purpose of budget development, it is assumed that up to 5 alternatives will be subjected to the detailed analyses described in this task.

Overall Protection of Human Health and the Environment

An assessment will be made to check whether each alternative meets the requirement that it is protective of human health and the environment. The emphasis of this analysis is on long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

ARAR Compliance

Federal and state responses to the AAD will be considered during the detailed analysis of alternatives. Each alternative will be analyzed to determine whether it attains the contaminant-specific, action-specific, and location-specific requirements identified during ARAR review.

Long-term Effectiveness and Permanence

Long-term effectiveness addresses the results of the remedial action in terms of residual risk after response objectives have been met. The components of long-term effectiveness will be identified for each alternative as follows:

- Magnitude of remaining risk from untreated waste or treatment residuals;
- The adequacy and suitability of controls that are used to manage treatment residuals or untreated wastes; and
- The long-term reliability of management controls for providing continued protection from residuals.

Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion assesses the degree to which alternatives employ recycling or treatment that reduces the toxicity, mobility, or volume of waste and/or contaminants.

Short-term Effectiveness

The evaluation of short-term effectiveness includes determining the short-term impacts of the alternatives during construction and implementation phases until remedial response objectives are met. The assessment includes short-term risks which may be posed to the community, the workers, and the environment during remedial action, the effectiveness and reliability of protective measures, and the amount of time until protection will be achieved.

Implementability

An analysis of implementability will include a review of the technical and administrative feasibility of the alternative along with the availability of the system.

The evaluation of technical feasibility will include:

- Constructability of the technology;
- Ease of undertaking additional remedial action;
- Ability to monitor the effectiveness of the remedy; and
- Maintainability of equipment.

In consideration of administrative feasibility, activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits for off-site actions will be examined.

The review of system availability will indicate whether or not the necessary equipment and specialists are available. If the solution requires long-term operation of a treatment, storage, and disposal (TSD) service, then the review must assure that long-term capacity will be available.

Cost

During the financial analysis, the cost associated with the following aspects of the project will be considered:

- Capital costs associated with development and construction;
- Operation and maintenance; and
- Present worth analysis.

State Acceptance

The technical or administrative concerns the State may have regarding each alternative will be addressed.

Community Acceptance

The section is used to evaluate those features of the alternatives the community supports, has reservations about, or opposes. This criterion will be addressed in the Responsiveness Summary, after receipt of comments during the public comment period.

3.3.2.2 Comparative Evaluation of Acceptable Alternatives

The analyses performed for each alternative in the detailed analysis of alternatives will be combined in order to rank alternatives and support a recommendation. The relative performance of each alternative will be evaluated in relation to each specific evaluation criteria. The advantages and disadvantages of each alternative to one another will be clearly identified. The comparative analysis of the alternatives will be presented in a narrative discussion and will include a description of the following:

- Strengths and weaknesses of the alternatives relative to one another with respect to each criteria;
- How reasonable variations of key uncertainties could change the expectations of their relative performance;
- Differences between the alternatives measured either qualitatively or quantitatively; and
- Substantive differences among the alternatives.

The evaluation of innovative technologies will include a description of their potential advantages in cost or performance and the degree of uncertainty in their expected performance.

The ranking system will provide each consideration a weight to allow a cost/benefit analysis to be performed. Incremental cost/benefit (C/B) analysis and decision analysis are each described below.

Cost/Benefit Analysis

A C/B analysis will be performed on the alternatives so that selection of an alternative can be made that provides the most cost-effective alternative with a favorable balance between protection of public health, welfare, and the environment. The C/B analysis will be evaluated with potential synergistic considerations of the sensitivity analysis.

Decision Analysis (Sensitivity Analysis)

A sensitivity analysis in conjunction with a C/B analysis will be used to screen the alternatives for selection. The variables to be evaluated for selection of the alternatives will be analyzed as to their weight (criticalness) in allowing an alternative to be viable.

3.3.3 Feasibility Study Report

A Draft Feasibility Study Report will be prepared presenting the results of the FS. Copies will be submitted to the U.S. EPA and the MDNR for their review. The U.S. EPA and the MDNR will review and provide comments on the draft document.

A Draft Final Feasibility Study Report will be prepared which incorporates U.S. EPA and MDNR comments on the Draft Feasibility Study Report. The Draft Final Feasibility Study Report will be made available for public review and comment.

3.3.4 Post RI/FS Support

This task includes efforts to prepare the responsiveness summary, support Record of Decision (ROD) activities, conduct any pre-design activities required, and the closeout of the contract. All activities occurring after the release of the public comment FS report will be reported under this task. Activities may include a pre-design report, attendance at public meetings, writing and/or review of the responsiveness summary, support on preparation of the ROD, preparing FS addendum, preparation of the final FS, review of QC of the work effort and contract closeout activities.

Following the close of the FS public comment period, a responsiveness summary will be prepared. This will include addressing public comment and questions concerning the RI summary and public comment and questions concerning the RI and FS. A draft responsiveness summary will be prepared and submitted to U.S. EPA for review and comment before being finalized. Transcripts of the public meeting and copies of written comments will be attached as appendices to this report.

Following completion of the FS, technical support will be provided to the U.S. EPA in their Record of Decision (ROD) or Enforcement Decision Document (EDD). This would include clarification of the FS, reviewing technical content of ROD documents, or assisting EPA regional staff in preparing briefing materials or visual arts. Additional analyses or evaluations of alternatives have not been budgeted for.

4.0 PROJECT TEAM ORGANIZATION

Figure 8 portrays the functional organization chart for this interim remedial action project. A group of people having diverse expertise will be utilized to successfully complete the project. Most of the expertise will come from within the U.S. EPA and WWES. Subcontractor services will also be required for specific tasks.

Responsibilities of the project's principal units are as follows:

U.S. EPA

- Provide authority and financial resources.
- Review and approve the technical approach to completing the study.
- Provide technical and quality assurance support.
- Review and approve study findings.
- Obtain site access.

Michigan DNR

- Review and consult regarding the technical approach to completing the study.
- Review and consult regarding the study findings.
- Review interim remedial response alternatives to help identify response objectives.

WWES ARCS Program Management Office and QA Team

- Review and approve the technical approach to completing the project.
- Assure that project employees have been properly trained and have the expertise needed to perform their assigned tasks.
- Provide technical support services to the project team as needed.
- Audit work progress and review study results to assure that the work conforms to accepted QA/QC provisions.

WWES Site Project Manager

- Ensure technically sound, defensible, complete deliverables.
- Manage the technical project team and assure that deadlines are met, quality control is observed and budgets are met.
- Arrange for support services as needed.
- Provide U.S. EPA with project management reports.

WWES Project Geologist, Engineer, and Environmental Compliance Specialist

- Perform or technically supervise the performance of the work identified in the Work Plan.
- Anticipate technical problems and recommend solutions.

The responsibilities of groups and individuals may change as the investigation progresses. Such changes would be implemented in order to benefit from specialized expertise of various staff members. The monthly report will indicate any significant changes that occur. The biographies for pertinent WWES employees are included in Appendix A of the Work Plan.

The following individuals have been assigned to leadership positions in the project.

ARCS Program Manager: Carl Malsom
Project QA Team: Jeff Sutherland, Scott Dennis
Site Project Manager: Elizabeth Uhl
Project Engineer: Mike Lawson
Project Geologists: Rick Trippel, Tom Timmermans
Environmental Compliance Specialists: Jim Rossi, Glenn Hendrix

5.0 SCHEDULE

The tentative schedule for the investigation is shown in Figure 9.

6.0 REFERENCES

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Appendix A

STAFF BIOGRAPHIES

Elizabeth M. Uhl

B.S. Geosciences, 1982
University of Arizona

M.S. Geology, 1991
Southern Illinois University

Ms. Uhl has 7 years of experience as an environmental consultant. She plays a significant role as project team member in large, diverse environmental programs for government and industry. Her broad understanding of current state and federal regulations allows her to work with the often complex environmental concerns of the client. In this regard she works closely with the client and WWES personnel to interact effectively with state and federal agencies.

Her professional expertise lies in designing and implementing geologic and hydrogeologic investigations. These vital investigative activities directly affect the selection of remedial strategies for the client's specific environmental concerns. She authors and implements work plans, and supervises project team members and subcontractors. Her strong background in hydrogeology provides experience in the assessment of organic and inorganic ground water and soil contamination, monitoring well network design, characterization of contaminated sites, and environmental sampling of ground water, surface water, soil, and sediment.

Her strong capabilities are demonstrated in these projects:

- Tri-County and Elgin Landfills: In an ongoing 3-year project, Ms. Uhl as project manager has led the project team in solving complex contamination problems at two adjacent abandoned landfills. These landfills have been designated as a priority cleanup site by the U.S. EPA. Ms. Uhl has been the key liaison interfacing with the U.S. EPA and Illinois EPA to achieve the federal and state required cleanup standards.
- Property Transfer: Ms. Uhl worked as project team member in an environmental assessment of an abandoned airport in Indiana. In this project the team identified areas of contamination, negotiated with the owner and supervised the remediation on the buyer's behalf. The cleanup objectives were met, and the property transfer was completed.

Ms. Uhl is affiliated with the following professional societies:

National Water Well Association
Geological Society of America

James E. Rossi

B.S. Chemistry, 1985
University of Michigan

MPH Environmental and Industrial Health, 1987
University of Michigan, School of Public Health

As Senior Project Environmental Scientist with WWES, Mr. Rossi prepares multi-media risk assessments to determine potential need of remedial activities at industrial and commercial sites. Mr. Rossi has significant experience in performing federal- and state-required risk assessments and in determining the relative human health and environmental hazards in complex settings.

Mr. Rossi's strong professional background includes working for five years as a senior associate scientist at Environ Corporation in Washington, DC. In this position, he completed a variety of human health and environmental risk assessment tasks including:

- Mr. Rossi has evaluated the risks presented by contaminants at numerous uncontrolled hazardous waste sites which are currently listed on the National Priority List of CERCLA sites in the eastern U.S. and midwest. These contaminants included volatile organic compounds, semi-volatile organic compounds, pesticides, PCB's and metals. These risk assessments have successfully met the needs of both potentially responsible parties as well as state and federal regulatory agencies.

- In his work at over 40 industrial and commercial facilities, Mr. Rossi evaluated the regulatory compliance history and liabilities presented by potential environmental contamination. As part of each project, he reviewed the handling, storage, and disposal of hazardous materials relative to environmental permit conditions.

Mr. Rossi's expertise is in the area of human exposure assessment. He has developed a model for U.S. EPA's Office of Drinking Water that assesses dermal absorption of contaminants from dilute aqueous solutions. For a major trade organization, Mr. Rossi developed a variation of this model to assess the dermal absorption of compounds in paper products.

Mr. Rossi is a member of the following professional society:

Society of Environmental Toxicology and Chemistry

Glenn A. Hendrix

B.S. Zoology and Limnology, 1977 (with honor)
Michigan State University

M.S. Biological Sciences (Aquatic Ecology), 1983 (with honor)
Michigan Technological University

Mr. Hendrix serves as a Senior Environmental Scientist/Limnologist. He assists clients with permitting requirements and compliance with environmental regulations. He conducts environmental studies for industry, government, and business, including environmental assessments, risk assessments, environmental fate and effects of toxic substances, limnological investigations, wetland studies and water quality studies.

Mr. Hendrix has completed a variety of environmental projects. These projects include: risk assessments; environmental assessments; hazardous waste facility permits; Remedial Investigations/Feasibility Studies; limnological investigations; water quality studies; and wetland identification, permitting, and mitigation.

Prior to joining our firm, Mr. Hendrix worked on a large rural non-point source pollution study sponsored by the U.S. EPA and developed a system for identifying critical areas that are non-point sources of pollutants in Michigan. He has conducted limnological and biological surveys of Lake Michigan, Lake Superior, inland lakes, and streams. He also coordinated a U.S. EPA-sponsored study of toxic contaminants in a large river system, including sampling, data analysis, modeling, and technical review.

Mr. Hendrix has written a number of articles and reports on the fate of toxic chemicals in aquatic environments, water quality, non-point source pollution, small quantities of hazardous wastes, and environmental assessment. He has completed training by the Environmental Protection Agency on wetland delineation and jurisdiction and Health and Safety Training for Hazardous Waste Operations and Emergency Response.

Mr. Hendrix is a member of the following professional societies:

National Association of Environmental Professionals
International Association for Great Lakes Research
American Society of Limnology and Oceanography
North American Lake Management Society
American Water Resources Association
Association of Wetland Managers

Richard J. Trippel, CPG

B.S. Geology, 1982
Ohio State University

As project geologist with WWES, Mr. Trippel works closely with project team members and subcontractors in field sampling, installing monitoring wells, aquifer testing, and collecting and interpreting data. His work provides the basis for evaluating sites for suspected contaminantion and implementing a remedial program for each client's specific concerns.

Mr. Trippel's extensive experience includes 4 years as independent consulting geologist in the oil and gas industry in Ohio and an additional 4 years as environmental consultant. Past experiences have proven to be especially beneficial to projects dealing with environmental concerns relating to regulations and practices of the oil and gas industry. His strong technological background and abilities as environmental scientist are demonstrated in the following projects:

- Working within new, more stringent state regulations, Mr. Trippel was part of a project team that evaluated whether a specific area was suitable for expansion of a large solid waste management facility. The project team determined subsurface soil and ground water conditions, permeability and other qualities of on-site soils to ensure that the expansion of the facility would be environmentally safe. Using air-coring drilling techniques, the soil permeability and ground water flow beneath the site was determined, providing the information needed for ultimate permitting of the facility.

- In this complex project, Mr. Trippel worked closely with local and state regulatory agencies and the client to address and resolve community concerns associated with the permitting of a central Ohio solid waste management facility. Because of extensive surface mining that had been done, the geological setting was complex and required the best technologies and techniques available to evaluate the site. The investigation and related studies led to obtaining a Permit to Install for the client.

Professional Affiliations:

American Institute of Professional Geologists
National Ground Water Association

Thomas J. Timmermans

B.S. Geology, 1985
Calvin College

M.S. Geology, 1989
Michigan State University

As a Senior Project Hydrogeologist, Mr. Timmermans provides technical expertise and project management for hydrogeologic investigations. He also integrates hydrogeologic information with other data on multidisciplinary projects including integration of data and modeling for risk assessments and remedial actions.

During Mr. Timmermans' five years in the environmental consulting profession, his responsibilities on projects have included design and supervision of drilling and sampling programs, design and analysis of aquifer tests, numerical and analytical ground water modeling, report writing, and providing expert testimony. His experience has also included acquisition and analysis of geophysical data and multi-variate statistical analysis of hydrogeological data.

Mr. Timmermans' Master's thesis included mapping of glacial deposits in the Mid-West and numerical modeling of glacio-isostatic deformation.

Mr. Timmermans' professional affiliations and awards include:

National Water Well Association (NWWA)
Affiliation of Christian Geologists (ACG)
American Scientific Affiliation (ASA)
1990 Receipient of the Excellence in Masters Research for 1989-1990 by the Department of Geological Sciences, Michigan State University
1988 Recipient of the Best Student Paper Award at the North Central Section, Geologic Society of America
1988 Recipient of the Scholastic All-American Collegiate Award by the United States Achievement Academy
1980 Recipient of the John Block Memorial Scholarship Award

Mike A. Lawson, P.E.

B.S. Chemical Engineering, 1984
University of California, San Diego

Professional Engineer, California
Registered Environmental Assessor, California

Mr. Lawson has over 7 years of engineering experience in environmental and hazardous waste projects. As project engineer with WWES, he directs staff in their performance of engineering tasks on multidisciplinary projects and coordinates work with other project organizations. He assures the quality of engineering projects for the client through this management.

Mr. Lawson's experience includes evaluating and designing waste management and environmental remediation systems, performing feasibility studies and providing scientific support for permit applications for the client.

Mr. Lawson has specialized experience in hazardous waste incineration--its system design, trial burn and test planning, feasibility studies, reporting, permitting, and operations. This expertise is demonstrated in the following projects:

- U.S. Army. Evaluation and design of candidate technologies for treatment of Basin F liquids at Rocky Mountain Arsenal in Denver, Colorado. Tasks included conceptual design, alternatives evaluation, selection of recommended alternative; and design, test planning, and hazard evaluation (PHA and HAZOP) for submerged quench incinerator.
- California Department of Health Services (DHS): Planning and reporting of a hazardous waste incineration demonstration test for contaminated soil from the Stringfellow NPL site in California. Tasks performed include preparation of the demonstration test plan in accordance with RCRA trial burn requirements, preparation of monthly progress reports, the demonstration test observation, and preparation of the demonstration test final report.

Mr. Lawson has designed numerous site remediation and environmental control systems, using technologies which include air stripping, carbon adsorption, soil vapor extraction, and catalytic and fume incineration.

Mr. Lawson is a member of the following professional societies:

American Institute of Chemical Engineers
American Institute of Chemical Engineers, Environmental Division

Jeffrey C. Sutherland, P.E., CPG

A.B. Geology, 1962
Cornell University

Ph.D. Geology, 1968
Syracuse University

Registered Professional Engineer - Michigan
Certified Professional Geologist, AIPG
Diplomate, American Academy of Environmental Engineers

As Director of Quality Assurance and Health & Safety, Dr. Sutherland develops and implements quality control and quality assurance procedures for our firm. He ensures that the necessary systems are in place to train staff in quality assurance procedures and that the necessary mechanisms for quality assurance are being followed. He serves as a manager of hydrogeology and multidisciplinary projects and as a technical resource for hydrogeology and land application of municipal wastewater.

Dr. Sutherland has managed numerous hydrogeological and interdisciplinary projects for ground water development, ground water cleanup, treatment of municipal wastewater through land application (upland, overland flow, wetlands), and hazardous waste site investigation. He has conducted research and published numerous articles on the technical and economic factors related to land application of municipal wastewater.

He is a member of the following professional societies:

American Institute of Professional Geologists
Association of Ground Water Scientists and Engineers (NWWA)
National Society of Professional Engineers
American Academy of Environmental Engineers
American Association for the Advancement of Science

Scott T. Dennis, CPG

B.S. Geology, 1984
Wayne State University

M.S. Hydrogeology, 1987
Western Michigan University

Certified Professional Geologist - American Institute of Professional Geologists
Certified Professional Geologist - Indiana, Tennessee

Mr. Dennis provides environmental services to governmental and industrial clients through his management of a staff of 20 professional scientists--hydrogeologists, geophysicists, and geologic engineers. His 6 years at WWES have seen a fast-paced growth of experience and responsibility, providing a natural foundation for his direction of Geological Services.

Mr. Dennis has conducted and managed numerous studies to evaluate ground water flow and contaminant transport. The results of these studies have been invaluable for designing effective remedial action programs and evaluating ground water flow regimes. His expertise with computer programs integrated with his practical knowledge and experience has allowed for efficient, accurate, and cost-effective modeling studies and hydrogeologic investigations.

Representative Project Experience:

- **Michigan. Confidential Client.** A complex manufacturing facility encompassing nearly 1,500 acres was seeking a way to coordinate past geotechnical and environmental studies which had resulted in the drilling of nearly 3,800 soil borings or wells. By combining all of this information into a single computer database, Mr. Dennis was able to develop a site-wide correlation of data. Using the efficiency of computerized data management, along with a three-dimensional ground water flow model, a concept for *total site containment* was developed to provide for cost-effective, proactive, and efficient ground water management.

- **Battle Creek, Michigan - Verona Well Field.** By combining his practical knowledge of hydrogeology with his modeling expertise, Mr. Dennis performed a comprehensive technical review of ground water modeling completed by the USGS and U.S. EPA. Mr. Dennis then served as expert witness on behalf of WWES' client for issues related to current and historical ground water flow regimes.

Michael Potter

B.S. Geology, 1987
Grand Valley State University

In addition to managing a staff of technical field specialists, Mr. Potter is actively involved as project coordinator in several hydrogeological investigations. His responsibilities include client contracts, well placement, supervision of drilling, soil identification and sampling, elevation surveying, ground water flow direction determination and in-situ permeability testing.

Prior to assuming the position of assistant manager, Mr. Potter was a hydrogeologist for the underground storage tank group. He has designed, coordinated and supervised a variety of field programs associated with hydrogeological investigations of leaking underground storage tanks.

Upon joining our firm in 1989, Mr. Potter worked for one year as a field technician. In that position his responsibilities included supervision of contractors during soil sampling and monitor well installation, tank removals, impoundment closures; field investigations involving sampling of soil, water and hazardous wastes.

He has participated in the U.S. EPA ARCS Program of RI/FS at three sites. He has a thorough knowledge of procedures required by the U.S. EPA in well installation, soil and surface sediment sampling, ground and surface water sampling, soil vapor testing and the documentation necessary to record, ship and track these samples.

Mr. Potter has completed the 40-hour OSHA safety training course and the 8-hour safety supervisory course. He is familiar with A, B, C and D levels of protection required in all field work.

Prior to joining our firm in 1989, Mr. Potter worked for a consulting engineering firm doing construction inspection, drafting, soil testing and report preparation. He served as the construction inspector on the reconstruction of the Hart Dam in 1987.

Mr. Potter is a member of the Association of Ground Water Scientists and Engineers (National Water Well Association).

Lucy B. Pugh, P.E.

B.S. Environmental Sciences Engineering, 1980
University of Michigan

M.S. Civil Engineering, 1981
University of Michigan

Registered Professional Engineer - Michigan and North Carolina

As Director of Engineering Ms. Pugh manages and works closely with a staff of chemical and environmental engineers. With over 10 years of progressive experience in environmental engineering, her technological expertise allows her to lead her staff in providing quality environmental engineering services for industrial and municipal clients. These services include all phases of environmental engineering--from evaluations of innovative and conventional technologies to full-scale process design, including:.

- evaluation of demonstrated and innovative technologies for ground water, soils, and solid/hazardous wastes;
- feasibility, treatability and full-scale studies;
- treatment of contaminated soils, sludges, wastewater and ground water;
- waste minimization;
- aerobic and anaerobic biological treatment, and *in situ* bioremediation.

Ms. Pugh has published and presented a number of technical papers at the Purdue Industrial Waste Conference and the Annual Conferences of WPCF and AWWA. Subjects include treatment of industrial and municipal wastewaters and contaminated ground waters, measurement of biomass activity and microbial contamination, and biological nutrient removal.

Ms. Pugh is a member of the following professional societies:

Water Pollution Control Federation
American Society of Civil Engineers
Michigan Section Scholarship Chairperson, 1987-1990
Michigan Society of Professional Engineers
National Society of Professional Engineers

She has received the following honors and awards:

Young Engineer of the Year, 1987, Ann Arbor Chapter,
Michigan Society of Professional Engineers
James R. Rumsey Award, 1987 and 1990, Michigan Water Pollution Control Association

Albert R. Webb

B.S.	Chemistry, 1973 (with honors) Central Michigan University
J.D.	University of Detroit School of Law, 1979
M.P.H.	Industrial Hygiene/Safety, 1986 (with honors) University of Michigan, School of Public Health

Mr. Webb serves as Occupational Health and Safety Officer for WWES' Environmental Services Division. In this role he develops and reviews corporate and divisional safety goals and objectives; evaluates safety programs for accomplishing those objectives; organizes and coordinates health and safety training programs; supervises medical monitoring; and develops and approves site health and safety plans for hazardous waste site investigations and related field activities.

Mr. Webb has conducted numerous projects for industrial clients involving the determination and fulfillment of their obligations for compliance under both the Emergency Response/Community Right-to-Know (SARA Title III), and Hazard Communication Standard regulations. He has also conducted Environmental Site Assessments of various properties related to real estate transactions. His work experience includes the performance of industrial hygiene surveys in a variety of industrial settings, and the supervision of employees' safe and efficient work activities under potentially hazardous work conditions.

For the past three years, he has conducted OSHA required Hazardous Waste Operations and Emergency Response (HAZWOPER) training for WWES staff and for outside contracting and consulting organizations.

Prior to joining our firm, Mr. Webb had over three years of experience as a Field Engineer and safety officer for an oil and gas exploration service company, and over six years of experience with environmental and industrial hygiene consulting firms.

Mr. Webb is a member of the following professional associations:

American Industrial Hygiene Association
American Public Health Association
American Chemical Society
National Safety Council

Thomas M. Brunelle, CPG

B.S. Geology/Biology, 1980
University of Rochester

M.S. Geology/Geochemistry, 1984
University of Rochester

Certified Professional Geologist
American Institute of Professional Geologists

As the Manager of the Geology Group, Mr. Brunelle supervises and manages a group of 16 professionals--hydrogeologists, geophysicists and geologic engineers--providing the client with a wide variety of environmental services. Mr. Brunelle assures quality services through his direction of the Geology Group, and performs comprehensive review of all geological reports, proposals and work plans as well.

Mr. Brunelle's expertise is in hydrogeological investigation and ground water remediation, with particular focus on geochemical interactions in ground water and soil regimes.

In his 8 years in the environmental field, Mr. Brunelle has provided industrial and governmental clients design and installation of ground water monitoring systems, interpretation of geochemical and hydrogeologic data for site investigations, and design of effective soil and ground water remediation systems. Mr. Brunelle has managed and directed major investigations of landfill sites, petroleum terminals and refineries, municipal well contamination sites, coal gasification sites, and numerous sites related to industrial solvent and petroleum releases.

Prior to joining our firm, Mr. Brunelle managed the hydrogeology staff at an environmental engineering firm in western Michigan, and before that time, spent approximately 1 1/2 years in petroleum-related geochemical research involving isotopic dating and tracing, using iodine-129. Mr. Brunelle's master's thesis focused on sediment sulfur geochemistry and sediment dating using carbon-14.

Mr. Brunelle is a member of the following professional societies:

- National Ground Water Association - Association of Ground Water Scientists and Engineers
- Soil Science Society of America
- American Society for Testing and Materials
- International Association on Water Pollution Research and Control
- American Geophysical Union - Hydrology Section
- Michigan Well Drillers Association - Ground Water Technology Division - President, 1991-1992
- American Chemical Society

Allen J. Reilly, Jr.

B.A. Biology, 1983
Carleton College

M.E.S. Environmental Sciences, 1989
Yale University

As Manager of Environmental Risk Assessment Services, Mr. Reilly assists clients in the design and implementation of innovative compliance strategies for a wide range of state and federal environmental regulations. He specializes in developing remedial cleanup programs for contaminated sites and has done so for a number of major manufacturing companies. Mr. Reilly evaluates various cleanup strategies and cleanup standards in light of projected cleanup costs, possible land uses, and potential regulatory ramifications. Using his training in both scientific and regulatory matters, Mr. Reilly is adept at reconciling the quantitative with the legal aspects of environmental risk assessment. He also works effectively with various regulatory agencies on behalf of WWES clients.

Mr. Reilly's curriculum at Yale was interdisciplinary in nature. His course work included environmental law, natural resource policy and management, natural resource law, risk and regulation as well as soil science, hydrology, and ecology. He possesses a strong background in laboratory/field research, having spent time at the Woods Hole Oceanographic Institution researching the effect of heavy metals on plankton.

While a student, he was awarded a Fellowship by the Environmental Protection Agency to analyze policy at the Office of Marine and Estuarine Protection in Washington, D.C. As a policy analyst at the EPA, he wrote technical guidances and policy statements on such diverse issues as the management of toxics in combined sewer overflow, the feasibility of requiring ambient monitoring as part of all NPDES permits, and the impact of toxics and floatables on near-coast marine processes. He also participated in several work groups responsible for revising draft regulations on the NPDES permitting program for municipal storm sewers and for a combined sewer overflow abatement strategy. In addition to his work with the EPA, Mr. Reilly conducted site visits for the Office of Technology Assessment in preparation for its report to Congress on the reauthorization of RCRA.

Patricia A. Fisher
Environmental Scientist

B.A. Biology, 1984
Dordt College

M.En. Environmental Sciences, 1989
Miami University

Ms. Fisher is an Environmental Scientist and assists clients with permitting requirements and compliance with various environmental regulations. She is involved with community relations for Superfund sites in the Great Lakes region, and conducts Phase I environmental site assessments, environmental assessments, limnological investigations, and wetland studies. She is also responsible for resolving water quality issues affecting our clients.

Ms. Fisher's background in resource analysis has exposed her to environmental problem solving, land use planning, water resource protection, and environmental education. Prior to joining our firm, Ms. Fisher worked as an environmental planner for a regional planning agency assisting local township governments and lake associations in the protection and improvement of water resources through proper land use practices.

Other experiences included work as a science librarian at Miami University. As an intern with the International Crane Foundation she worked with prairie habitat restoration in southern Wisconsin. Ms. Fisher also participated in an Environmental Resource Protection Plan Committee in reviewing the city master plan for a northern Michigan community. She has completed training by the Wetlands Training Institute on wetland delineation and jurisdiction and Health and Safety Training for Hazardous Waste Operations and Emergency Response.

As a certified environmental analyst and naturalist, Ms. Fisher is knowledgeable in land and water resource interpretation, assessment, inventory, and management.

Ms. Fisher is skilled in aerial photograph interpretation, graphic illustration, map interpretation, and forest ecology sampling.

Ms. Fisher is a member of the following professional associations:

- Association of State Wetland Managers
- North American Lake Management Society--Michigan Chapter
- Society for Ecological Restoration and Management
- International Crane Foundation